

LECTURES

ON THE

PRINCIPLES OF SURGERY.

BY

JOHN HUNTER, F.R.S.

WITH NOTES

BY

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PREFACE.

THE following Lectures are printed from a very full and accurate copy, taken in short-hand by Mr. Henry Rumsey of Chesham, to whom I am indebted for the permission to make them public. They were delivered in the years 1786 and 1787, after which period I have not found any copy, excepting a very short and imperfect one in the Museum of the Royal College of Surgeons, dated 1791, by Mr. James Pearce. There are also in the College Museum five other copies, which are respectively attributed to Mr. Twigge, Mr. Hopkinson, Mr. Parkinson, and Mr. R. Keate; the fifth being only a partial transcript of a copy by Dr. Joseph Adams, Mr. Hunter's biographer. Of all these, Mr. Parkinson's is by far the most full and accurate, although in these respects it falls very far short of the accuracy and fullness of Mr. Rumsey's copy, from which the ensuing lectures are printed. Indeed, from the fullness of the latter, one might almost suppose that the writer had had access to the Hunterian manuscript; for, besides being generally more full, it never omits examples and illustrations in proof of opinions, which the former ones frequently do. The style also is characteristically Hunterian.

I am also indebted to Sir. Benjamin Brodie, to Professor Macartney, and to Mr. Frederick Tyrrel, for the use of copies in their possession, the first of which is ascribed to Mr. Howison, the second was taken by the Professor himself, and the third by Mr. Robert Lees. The last of these (bearing date 1785 and 1786) is the most valuable, being not only the most full, but abounding with interlineations, which there is every reason to believe were added during

an attendance upon a second course of the same Lectures. These last-mentioned copies, as well as Mr. Parkinson's, have been had recourse to whenever occasion required, but in general, and with very few exceptions, the printing has been conducted from Mr. Rumsey's. Occasionally it has been found necessary to retrench redundancies and repetitions, and to substitute one word for another having a synonymous signification.

The value of these Lectures, I suppose, will not be questioned, nor the interest which attaches to them denied. Besides the luminous general views on Physiology and Pathology which they contain, they also abound in useful facts and the most valuable practical suggestions. In some respects they may be regarded as amplifications of his published opinions, but in other respects they enter upon entirely new subjects of the greatest interest to the Surgeon.

The notes which accompany these Lectures are not numerous; for as many of the subjects treated of will again come under consideration in the course of the Treatises, it seemed more convenient to refer any observations that might be required, to those parts of the work, in which the Author has expressed his opinions in his own undoubted language. In the few observations which the Editor has deemed it necessary to make, he has sometimes had recourse to authorities, which he has not always thought it necessary to mention particularly. He trusts, however, that this general acknowledgment will obviate the suspicion of his wishing to appropriate unjustly the labours of other men.

JAMES F. PALMER.

38 Golden Square, April, 1835.

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LECTURES

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PRINCIPLES OF SURGERY.

CHAPTER I.

INTRODUCTION.

Introductory remarks.—These lectures to contain the results of Mr. Hunter's own observation;—intended to explain the general principles of the art;—these the necessary guides to practice.—Mr. Hunter's opinion of operations;—motives for lecturing.—To commence with some account of physiology.—Preliminary observations on matter;—its general properties;—our perception of matter:—attraction;—repulsion;—properties added to constitute organized matter.—Of animal and vegetable matter;—its origin in, and return to, common matter;—but distinguished from it by peculiar properties;—growth;—propagation of the species:—existence under two states, the living and the dead;—three modes in which it may be considered: 1st, Living; 2d, Chemically when dead; 3d, In a state of decay, and return to common matter.—Errors of former physiologists, in explaining vital actions by mechanical or chemical operations;—this error to be corrected.—Consideration of animal matter in particular;—and especially of the human body;—but information to be drawn from other animals and vegetables;—also from diseases and malformations.

MR. HUNTER used generally to commence by stating that it was his intention, in these lectures, to give only the results of his own observations and experience, because the opinions of others might be found in their works. I do not mean, said he, that all I say in this course will be entirely new, and that none of the opinions and observations which I shall deliver are to be found in any publications, for there are many facts too obvious to have been overlooked in the most ignorant days of physic. I intend in this course to include some of the most interesting parts of surgery, principally those subjects on which I have had opportunities of making many new, and I hope useful observations, so as to put our art, in many respects, in a new point of view. Many of my ideas, and the arrangement of my subject, are new, and consequently my terms become in part new, for two ideas cannot be expressed in the same terms. I am led to suppose my ideas are just, because they have

in some measure stood the test of time; and what is the most incontestible proof of their correctness is, that they have been adopted by others; and I hope my *terms* will be found expressive of the things meant, and that they are so appears evident, from their having been employed in several late publications on surgery.

I do not intend to give my lectures as a regular course, but rather to explain what appear to me to be the principles of the art, so as thereby to fit my pupils to act as occasion may require, from comparing and reasoning on known principles. I shall suppose you already acquainted with the structure of the parts of the human frame, and must observe, that a knowledge of the healthy and diseased actions, or, in other words the principles of our art, are not less necessary to be understood than the principles of other sciences; unless, indeed, the surgeon should wish to resemble the Chinese philosopher, whose knowledge consisted only in facts. In that case the science must remain unimproved until fresh facts arise. In Europe philosophers reason from principles, and thus account for facts before they arise. Too much attention cannot be paid to facts; yet too many facts crowd the memory without advantage, any further than that they lead us to establish principles. By an acquaintance with principles we learn the *causes* of diseases. Without this knowledge a man cannot be a surgeon. Surgeons have been too much satisfied with considering the effects only; but in studying diseases we ought not only to understand the effect, as inflammation, suppuration, &c., but also the cause of that effect; for without this knowledge our practice must be very confined, and often applied too late, as in many cases it will be necessary to prevent the effect. In the bite of a mad dog, for instance, the disease will be prevented by removing the part; in the venereal disease, in the case of chancre, we must not only know how to cure the chancre, but also to prevent its effects on the constitution, which is done by giving mercury internally. On the other hand, it would be often proper to increase the effect, which can only be done when we know the cause.* In many cases, where the effect could not be

* [By the "law of nature" is meant the invariableness or uniform constancy of certain results following certain given conditions, the agents (which for the most part are unknown and invisible), being denominated the *cause*, the resulting phenomena the *effect*, and the conditions under which that effect is produced, the *law*. Thus, all bodies fall to the earth, and all bodies also suffer an expansion of their particles by the application of heat. Here the principles of gravitation and heat are the causes, the descent and expansion of the bodies, the effects, and the rates according to which these effects take place, the laws of gravitation and heat. Causation is attributed merely in consequence of the invariableness of the phenomena, and not in consequence of any knowledge which we possess of the intimate relation of causes and effects.

It is not in general difficult to deduce the laws of physical agents, in consequence of the power which we possess of simplifying and varying the conditions of our experiments, so as in the first instance to separate all extraneous influences or disturbing causes, and in the second place to verify the results thus obtained by every possible combination of opposing circumstances. Such certainty, however, is rarely attainable in regard to organised bodies in consequence

prevented, or afterwards either removed, diminished, or increased with advantage, it will be proper to change it to some other more in our power to remove, as, for instance, by converting the venereal into common inflammation. If the disease is already formed, we ought to know the modes of action in the *body* and in *parts*, in their endeavour to relieve themselves; the powers they have of restoring themselves, and the means of assisting those powers. Or, if these prove insufficient, we judge, by all the attending circumstances, how far excision may be necessary, and what condition of the constitution is most favourable for an operation. To determine on this last point is exceedingly difficult, and in some instances exceeds our present knowledge. I lately saw a patient die in a few hours, of no other operation than the excision of a small tumour from the arm; another, by the removal of one from the abdomen; a third, by castration; and within these two days I assisted at an operation for fistula in perinæo, sixteen hours after which the patient died. Now all these patients seemed previously in good health, and perhaps the cause of death, and the particular circumstances of the constitution which render operations thus hazardous, will never be understood.

This last part of surgery, namely, operations, is a reflection on the healing art; it is a tacit acknowledgment of the insufficiency of surgery. It is like an armed savage who attempts to get that by force which a civilized man would get by stratagem. No sur-

of the reaction of the parts of which they consist upon one another, and the consequent impossibility of observing the effects of organic agencies in their simple state. The conditions under which any given class of phenomena are observed are continually varying, and a variety of extraneous causes are mixed up in almost every case, so that, from the most careful experiments, it is still extremely possible to mistake the conclusion, and to deduce laws which are expressive only of a part of the facts. These circumstances afford no just ground for under-valuing physiological principles, although they are calculated to inspire a wary caution in arguing with too much positiveness from principles of this kind. We would say, "*Est quodam prodire tenus si non datur ultra.*"

It is scarcely necessary to observe that causes differ greatly among themselves. It would be absurd to confound the principle of heat, the expansion of steam, and the machinery by which the power thus generated acts, as causes of the same kind. The remote and the proximate cause in such a case have no immediate relation, but are connected together by a number of intermediate circumstances which, like the steps of an argument, unite the conclusion to the premises. It is very necessary to bear this in mind in physiological reasoning, in consequence of our almost total ignorance of these intermediate links in the chain of causation. In the instance above adduced by the author, we have no knowledge of the *mode* in which the poison of a rabid animal, or the poison of syphilis, produce their effects on the animal body; nor how mercury and other medicines should tend to eradicate the latter from the constitution. We are unable in these cases to advance a step further than to perceive the necessity of absorption of the poison, after which all is conjecture. A full perception of the whole sequence of effects would doubtless at once discover the precise nature of the remedy, as well as the proper cases in which it should be administered.

These few observations have been made in consequence of the indefinite and not very philosophical manner in which Mr. Hunter sometimes employs the word *cause*. The final and efficient causes are frequently confounded.]

geon should approach the victim of his operation without a sacred dread and reluctance, and should be superior to that popular *éclat* generally attending painful operations, often only because they are so, or because they are expensive to the patient.

Mr. Hunter next mentioned his motives for lecturing; showing that he did not do this with a view to pecuniary gain, since the time thus expended might be employed more profitably in extending his connexions and enlarging his practice. I have seen, said he, as much practice, and made a larger collection of diseased preparations than perhaps any man in Europe, all of which I find to correspond with the opinions I have formed of the nature of the respective diseases. In the years 1761 and 1762, having been already engaged ten years in the profession, I attended the army, without which I should have been unable to give my opinion concerning gunshot wounds, which rarely occur in civil practice. In the year 1768 I was called upon to be a teacher of anatomy, but I congratulate myself that I did not become so, as it could not have failed of engaging my attention too much to admit that general attention I have been able to pay to surgery; and the necessity I should have been under to read might have occupied me too much, and prevented my forming habits or established modes of thinking.—In the years 1772, 1773, and 1774, I had frequent opportunities of giving my opinion in private, and had generally the satisfaction to be heard with candour. Since I have lectured, I have scarcely found a pamphlet without some of my opinions, and often my very language, as adhesive and suppurative inflammation, &c. But what more than all induced me to lecture, was the great advantage every one finds by putting his thoughts into writing. A man can never tell how much he knows till he arranges his knowledge, and then he can tell how defective it is; hence it is that almost all the authors of any consideration in physic have been public teachers.

In the present lectures it is my intention to begin with the physiology of the animal economy in its natural or healthy state; and then to come to pathology, or the physiology of disease, which may be called the *perversion of the natural actions of the animal economy*. Amongst the latter I shall treat first of *accidents* the most simple or natural, or *diseases spontaneously arising*; next, of the *means of restoration*, on which I shall be particularly full,—of these the first is *adhesive inflammation*, commonly called healing by the first intention; then of inflammations tending to *suppuration, granulation, and cicatrization*: after these I shall consider the *specific diseases*, as *locked jaw, scrofula, &c.*: the *poisons* next, as the *venereal disease, cancer, &c.*

Of Matter; and first of the Distinction between Animate and Inanimate Matter.

I must now beg the close attention of the gentlemen present, as

I shall be a little abstruse in the present lecture, which I intend as an introduction to all animal matter.

Before we endeavour to give an idea of an animal, it is necessary to understand the properties of that matter of which an animal is composed; but the better to understand animal matter, it is necessary to understand the properties of common matter; else we shall be often applying our ideas of common matter, which are familiar to us, to animal matter, an error hitherto too common, but which we should carefully avoid.

By our senses alone is matter demonstrable. If a man did not see, he would have no conception that there was such a thing as light; if he was deaf, he could have no idea of sound; if he had no touch, no taste, no smell, in short if he had no sensation at all, (which is easily conceivable), he would not know that there is such a thing existing as matter. On the other hand, it is from matter alone that we come to a knowledge of our senses; so that the only proof of the existence of either is by their reciprocal effects.

An animal, then, must be composed in such a manner as to be susceptible of impression, which impression consists of an alteration in the part impressed; and matter must make the impression on us before we can become sensible of its existence. Matter is in itself, however, only an abstract idea, and it is not the matter itself but some of its properties which make the impression, as sourness, heat, &c. When we see a man, it is not the man himself or the matter of the man that makes the impression, but the light which he reflects, and which our eye has the power of collecting to one point, so as to give a determinate shape on the organ of sight. Now the act of seeing is that impression made on our eye which gives us an idea of a body exterior to us, exactly similar to touch; it is an impression made of a given figure. Every man might be able to see simply with every part of the body as well as with the eye; for if you were to place before my skin a refracting glass, so that the image should be thrown on my body of the same shape as that which is exterior, if my feeling was so very delicate as to distinguish this shape, it would give me the same idea as seeing. A drum has no sound in itself, but it has the power of putting the matter of the air into action, which produces the idea of sound by its impression on the organ of hearing. The sense of touch would appear most to contradict the above statement; but touch only arises from the resistance of matter, which resistance alters the form of the part touching, and the alteration causes feeling. If it was the matter itself which caused the sensation, we ought to have as many kinds of matter as we have of sensation; but our sensations correspond with the different properties of matter, not with the different kinds.

But to return to my subject: by matter we mean all that composes this globe of the earth on which we live, and which is probably formed of only a few substances differing in specific pro-

perties from each other, but which when compounded produce a very great variety, and of course these cause a great variety of sensations in us. Matter, thus compounded, appears to us in one of the three following states, a state of solidity, fluidity, or vapour.

The first, or solidity, appears to be the natural state of matter; the other two seem to involve a kind of *force*, especially vapour.

The first of the various properties of matter is attraction: of this there are many kinds, of which I shall first mention elective attraction, which is a disposition in all matter to unite with some particular kinds of matter rather than with others, forming with them a compound, which at the same time that it is a compound, seems homogeneous. Elective attraction can only take place when bodies are in a fluid state or in vapour; it would appear to be a kind of choice, and it is one of the most refined properties of common matter, producing new compounds by a species of generation, but annihilating the old by the same action. This property is given to matter for the purpose of forming various regular solids and fluids of which the world is composed, and it is this that gives us such variety.

Secondly. By a particular attraction, or by an increase of the same attraction, these parts are brought into closer approximation: this we call the attraction of cohesion, by means of which attraction bodies are kept in one mass. When bodies are so subdivided as to be reduced to their constituent particles, still each particle has its centre of gravity on which it may be said to move, from whence arises fluidity. So that a fluid would appear to be a body reduced to its original parts; the attraction of cohesion is destroyed, but each particle has its centre of attraction or gravitation. As the centre of the globe attracts every particle of matter that is in it, so every mass of matter, simply as matter, has an attraction in its centre, by which it can bring bodies to it or keep them in contact with it. If we were to let drop some quicksilver, and it met with no resistance, it would assume a globular form: this is not from the attraction of cohesion, but from the attraction of gravitation. It must be observed, however, that where the attraction of cohesion is but slight, as in fluids, this will not take place, unless there is some affinity, as between acids and water, spirits of wine and water, &c. Water and oil will not unite by this species of attraction when in a fluid state.

There are other general properties which arise out of the attraction of cohesion, such as figure, magnitude, &c. These properties are those which make bodies fit subjects for mechanics, but they are not the only ones necessary. A clock may be made correctly, but yet it will not go until we bring in some active power, such as gravitation, the raising of water into steam, &c. Thus we find something like the life of mechanics, which is not matter, but a property belonging to it; what is simply mechanical, that is made of inert matter, must have, as it were, a soul to put and continue it in motion.

When all these properties have their full effect they produce various other effects, and become the regulators of the whole mass, confining its motion, space, &c.

These are some of the properties of common matter. How far repulsion is a universal principle I am not able to determine; I should much suspect that it is not so general as the others. That there is such a principle in nature is evident, because neither fluidity nor vapour could take place without it; perhaps heat is the great repulsive property, at least it counteracts attraction and produces repulsion amongst the particles of matter when diffused through it.

Thus the matter of the globe is in general so regulated, by properties stamped on it at first, that in its common actions it cannot err. But we find that matter has been carried much further in some other properties than in those just mentioned; it has undergone changes not in the least connected with or arising out of them, and its properties are of course entirely different; seeming, as it were, a monstrosity in the combination of matter. Its mode of continuance, by preparing within itself matter similar to itself, is entirely different.

These changes produce the animal and vegetable or organic portion of the world.

Of the Matter of Animals and Vegetables.

Animal and vegetable matter has certainly arisen out of the matter of the globe, for we find it returning to it again. Both are subject to the laws mentioned above as regulating common matter, but they are so different, from their peculiar modification, as to appear at first like originally distinct species of matter; but they will be found, on investigation, to be only a new modification of matter.

This change in the original principles of matter seems to be equally distinct both in animal and vegetable matter, and the first principle of action of those two substances seems to be in great measure the same; however, there are marks by which they can be distinguished. The connexion of these two modifications of matter with common matter has never yet been traced, nor has the gradual transition from one to the other been imagined; and if those substances had not reverted into common matter by their decomposition, it never could have been suspected that they were originally composed of the same materials. For these reasons they have been ranked by themselves.

Animal and vegetable substances differ from common matter in having a power superadded, totally different from any other known property of matter, out of which arise various new properties.

Animals and vegetables have a power of action within themselves, are capable of increasing their own magnitude, and possess

the power, as it were, of working themselves into form and a higher state of existence. This power of action and capability of increase requires a supply of materials, as well for the increase as for the waste arising from action. This supply appears not to be wholly the same in both, though perhaps it may be. The idea of a supply always supposes a resource distinct from the thing supplied, and no waste parts can ever perfectly revert into the thing itself without first going through all the changes which first brought it into a fit state.

This supply is furnished by the materials of the globe. Vegetables alone appear to have a power of immediately converting common matter into their own kind. Animals probably have not that power, therefore are removed further from common matter; so that a vegetable seems an intermediate step between common matter and animal matter. But observation will show that vegetables can readily convert both animal and vegetable matter into their own substance, as in the case of dung, which increases the natural growth of plants.*

Both have a power in propagating their kinds by a production out of themselves, by which means the stock is replenished.

Both are capable of being in two states: one of these is the living state, which we have been considering, the other is the dead state.

Hence both animals and vegetables are capable of being considered in three ways. 1st, In their power of continuance and production, when possessed of their natural powers of action or life. 2d, In their nature chemically as matter, which can only be considered when they are dead. 3d, In their decay, or spontaneous reduction to common matter, when life is gone.† In all these operations they are totally different from common matter.

* [It is highly probable that the different proximate elements of vegetable and animal substances hold different ranks in the scale of organised substances, in the same manner that one animal ranks higher in the scale of organised beings than another. Thus, starch, sugar, and woody fibre among vegetable substances, and gelatin, albumen, and fibrin among animal substances, are *raised*, as it were, from one to the other by successive processes in the animal or vegetable economy; so that fibrin may be regarded as the substance most highly animalized, or as possessing the distinctive properties of an animal substance in the highest possible degree. In this view, vegetable life, which subsists almost exclusively on carbonic acid gas, and graminivorous animals, which are able to extract nutriment from vegetable substances, may be regarded as subservient processes, intended to prepare the common elements of matter as nutriment for the more perfect animals,—which, however, afterwards undergoes a series of further processes in the bodies of these animals, in order to fit it for all the purposes of the economy. Sennebier and Saussure have satisfactorily shown that decayed organic remains do not nourish plants by being absorbed in their unmodified state, but by affording a more abundant supply of carbonic acid gas, which, in combination with water, forms the principal aliment of vegetables. There is no process in vegetables corresponding to digestion in animals, and hence the food of plants is spontaneously evolved by the natural processes of fermentation and putrefaction.]

† [There are many other distinctions between organised and inorganised bodies, which, however, it is unnecessary to consider in this place.]

The first distinction, or life, in which consists the power of self-preservation, is the antidote to the two last, since before either of these can take place the whole part must be deprived of the living principle. When in the first state, their actions are either natural, the whole being in harmony, and every part acting in concert with the rest, which is called health; or they are unnatural, which constitutes disease, the tendency of which is to destroy the whole.

When chemically considered, both animal and vegetable matter are found to be acted on by different substances, or are capable of solution in other bodies, as concentrated acids, alkalies, &c., in which respect they are pretty similar to one another. Both are capable of being acted on by fire; but in this process we find each yielding some substances peculiar to itself;—animal matter when distilled yields water, volatile alkali, empyreumatic oil, and calcareous earth;—besides these there is a small proportion of iron, which does not appear, however, to be a constituent part of the whole animal body, being chiefly procurable from the blood; a small proportion of their substances may also be found in the blood.*

In their decay, both animals and vegetables go through a series of regular spontaneous changes, the succeeding one arising entirely out of the first, and the next out of this, until the whole return to common matter from whence they arose, for to the earth they must return from whence they came. In this natural process we find animals and vegetables yield many substances not to be found in them before these changes, also not to be found in common matter. This process I call fermentation, and it is peculiar, I believe, to vegetable and animal matter.

The processes carried on by chemistry and fermentation, which can only take place when the parts are dead, have been introduced by physiologists into the living animal economy; and, not satisfied with this, they have brought in mechanics to account for many of the operations of vegetables and animals. But, for the purpose of distinguishing more accurately between mechanical, chemical, and vital operations, and the circumstances under which the two first are applied to the living body, let us consider them a little further.

The actions and productions of actions, both in vegetable and animal bodies, have been hitherto considered so much under the prepossessions of chemical and mechanical philosophy, that physiologists have entirely lost sight of life; and perhaps they have

* [Vegetable substances are nearly all composed of oxygen, hydrogen, and carbon,—carbon, for the most part, being the preponderating ingredient. In some few examples nitrogen is likewise present. The proximate principles of vegetables, or those substances which exist ready formed in plants, are exceedingly numerous, as gum, starch, sugar, &c., amounting in the whole to not less than forty-five or fifty substances, characterised by different properties. Animal substances, on the contrary, at least all the principal animal substances, contain nitrogen as well as oxygen, hydrogen, and carbon, and the proximate elements are not so numerous as those of vegetables. The animal fats, which are considered by many as a natural store of nutriment, contain no nitrogen, and therefore approximate to vegetable products.]

been led to this mode of reasoning because these properties are much more familiar, more adapted to our understandings, and more demonstrable than the living properties of organized beings. But unless we consider life as the immediate cause of all actions occurring either in animals or vegetables, we can have no just conception of either vegetable or animal matter. No wonder, then, that the theories of the older physiologists are ill built and ill supported, their principles being false. Many of the effects both in animals and vegetables might at first sight appear to be chemical, or the consequence of fermentation. The production of many juices of plants, such as gums, acids, sugar, &c., would seem to be of this kind ; but all arise from natural actions of the vegetable, and do not belong to chemistry. No chemist on earth can make out of the earth a piece of sugar, but a vegetable can do it. Digestion, the formation of the blood, and all the secretions of an animal, might at first appear to be of this sort ; but that they really are not chemical products I am clearly convinced. If an ingenious man undertook to account for every change in matter by fermentation, there is no change in nature that might not be brought within his definition. The living principle itself would be shown to arise from fermentation ; brain, muscles, bones would grow from fermentation, since they are all formed from the blood, and yet the blood is not found in them.—Of all things on the face of the earth definitions are the most cursed ; for if you make a definition you may bring together under it a thousand things that have not the least connexion with it.*

* [By the fermentation here spoken of is not meant that process of spontaneous decomposition, occurring under the conditions of heat and moisture, to which the appellation is restricted by modern chemists, but a vague chemical disturbance, in the course of which a new and undefined arrangement of the elements was imagined to take place.

Mr. Hunter, in his zeal for the vital principle, has probably gone too far in excluding the agency of chemical causes. There is not the least reason for supposing that the vital principle is able to confer new properties on matter, or to transmute one matter into another, so as indiscriminately to employ other substances than those which it does for the repair of the body and its various secretions ; on the contrary, there seems every reason for believing that the elementary particles exert the same affinities under the influence of vitality that they do in the laboratory of the chemist, and that if it were possible to present these to each other out of the body under precisely the same circumstances that they are presented in the body, and in the requisite states and proportions, the same combinations would take place, and the same results would be produced. The vital principle may not perhaps improperly be compared to the principles of heat and electricity, which exert an influence over the affinities of matter without essentially altering its nature ; but the great distinction between organic and ordinary chemistry is not less in the nature of the agent than in the minute and appropriate apparatus by which that agent operates. All the processes of organic life, referrible to this head, are executed, as it were *anatomically*, by an arrangement of parts infinitely small ; by which the affinities of the acting bodies are brought together in modes which cannot artificially be imitated by the chemist. The following observations by the reviewer of MM. Tiedemann and Gmelin's Treatise on Digestion apply to the present question :—"Je suis loin de nier qu'il y ait dans les actes du corps vivans quelque chose de special,

What I call fermentation, only takes place in animal and vegetable matter when dead. It is that change which takes place in the substances themselves out of their own spontaneity, without any external assistance. Chemistry is a kind of force on things to decompose them. In the process of fermentation, vegetable matter goes through intermediate stages, in which it is neither vegetable nor common matter; the same with animal matter during putrefaction. But in all the productions of a living animal or vegetable, the substances produced are animal or vegetable matter. The only substance produced in an animal which cannot be called animal matter is the earthy matter of bones, and of some diseased parts:* it appears also that, in some of the secretions of animals, the products produced have none of the original properties of animal matter, as the sugar of milk, the bitter principle in the bile, these not having been found in any of the natural solids or fluids by any process whatever. But this does not come up to my notion of fermentation, for no process of fermentation of animal or vegetable matter ever produced either one or the other; and even in vegetables, where sugar seems to constitute part of the plant, it is formed by the action of the vegetable. If ever any matter is formed in any of the juices secreted in any part of a vegetable or animal body similar to what arises from fermentation, we may depend on it it arose from that process, but we may also depend on it that there is a defect of the living principle in those cases,

The conversion of water into vegetables, which is vegetation, or of vegetable and animal matter into animals, which is animalization, is not a change taking place according to the nature of the substance, but is effected by the actions of the vegetable or animal. The different juices formed from the blood, called secretions, differ not from the nature of the blood as animal matter, all giving nearly the same substances when analysed, or subjected to fermentation. Nor can the substances formed in a vegetable be formed, by any process that we know of, from water.† We might suppose that fermentation would produce an animal from a vegetable, because in this change “a decomposition of matter and a new combination” is effected; but fermentation never could bring back dead animal or vegetable matter to living, so that it does not correspond to the

quelque chose qui reconnaît d'autres lois que celles qui régissent les corps bruts; mais ces dernières interviennent, sans aucun doute, plus qu'on ne le pense généralement dans les fonctions de nutrition; et c'est mieux servir la science de la vie de reconnaître cet intervention, et de l'étudier jusqu'à son extrême limite que devoir partout de la vitalité sans attacher à ce mot un véritable sens.”]

* [It is a question with some geologists whether lime is not essentially an animal product.]

† [The refinements even of modern chemistry have not yet enabled us to form any animal or vegetable principle *ab origine* from any combination of the ultimate elements. The substance called oxalamide, obtained by Professor Faraday from the oxalate of ammonia, approaches in character to an animal product, although it is not actually so. A few other examples of the same sort might be mentioned.]

above definition which has been given of it. This single circumstance throws more light on the power of the stomach than we are yet aware of, for dead matter subjected to it is not obliged to undergo any change as matter, but goes through that process which produces life.*

In treating of an animal body I shall always consider its operations, or the causes of all its effects, as arising from the principle of life, and lay it down as a rule that no chemical or mechanical property can become the first cause of any of the effects in the machine. But as all animals have form and motion, which motion is directed by that form, these motions become mechanical, so that every motion may be truly called mechanical. Mechanics are therefore introduced into the machine for many purposes. The living principle, however, in itself is not in the least mechanical, neither does it arise from, nor is it in the least connected with, any mechanical principle.

Having thus given a general idea of these singular combinations of matter, I shall now confine myself to animal matter. But before I treat of the diseases of the animal body, which is the intention of these lectures, it will be necessary to give such general ideas of the subject, and to lay down such axioms and propositions, as will enable you to follow me through all the necessary descriptions of preternatural actions of the machine. This matter we must consider in two points of view: 1st, in its production; 2dly, in its continuance. This leads me into a new field, and exhibits properties very different from all the other properties of matter. It will be necessary, I say, to have clear and distinct ideas of the difference between animate and inanimate matter, in order to know when and where the animal principle acts, and when other principles are made use of in an animal body in accomplishing all the different purposes of life. The human body is what I mean chiefly to treat of; but I shall often find it necessary to illustrate some of the propositions which I shall lay down from animals of an inferior order, in whom the principles may be more distinct and less blended with others, or where the parts are differently constructed, in order to show from

* [There are grounds, I think, for believing that the first rudiments of life, or the revivification of dead animal matter, actually commences in the stomach.—Digestion, however, is a complicated chemical process, and not of that simple kind that might be inferred from Mr. Hunter's language. (See Tiedemann and Gmelin, and Prout.) The transformation or passage of common matter under the empire of physical laws to living matter which exists in defiance of those laws, is a mystery which will perhaps never be completely understood. So far as observation has gone, the steps of this transformation are gradual and complicated; the products of each successive process always advancing from a lower to a higher degree of animalization. If therefore we regard life as a super-added principle, we cannot but observe that it is communicated to common matter only in proportion as this matter is animalized. In short, certain conditions of the recipients of life seem necessary before it can be communicated, and the higher the manifestations of life the higher are these conditions. The manifestation of intellect in proportion to the development of the brain presents an example very analogous.]

many varieties of structure, and from many different considerations, what are the uses of the same parts in man; or at least to show that they are not for the uses which have been commonly assigned to them; and as man is the most complicated part of the whole animal creation, it will be proper in the first place to point out general principles common to all this species of matter, that I may be better understood when I come to the more complicated machine, namely, the human. Besides having recourse to many of the inferior orders of animals for the elucidation of some of the phenomena of the more complicated orders, we are also obliged to Disease for many of our hints on the animal economy, or for explaining the actions of parts, for the wrong action of a part often points out what the natural action was, and itself gives an idea of life. Disease often corrects our imagination and opinions, and shows us that such and such parts cannot have the uses commonly attributed to them, and therefore brings us a step towards the knowledge of the true use. Monstrosities contribute to rectify our opinions in the same if not in a more intelligible manner. A monster is either from a deficiency of parts which can be produced from art (and often is from necessity, as in operations), or else from a modification caused by a wrong arrangement or construction of parts, which will produce an unnatural action, by which means the natural action may be known.

CHAPTER II.

ON THE VITAL PRINCIPLE.

Difficulty of conceiving of this principle;—complex in its effects, but simple in its essence; not the result of any perceptible arrangement of matter;—may result from a peculiar arrangement of the ultimate particles, giving rise to a principle of preservation;—this the simplest idea of life;—illustrated by magnetism in iron.—Erroneous comparison of life to mechanical powers.—Action not an essential property of life.—Life without action;—vitality of an egg;—experiments;—but action promotes the continuance of life.—Seeming exceptions to the preservative power of life;—peculiar form of putrefaction in certain bodies; death of a part of the body previously to general death.

ANIMAL matter is endowed with a principle called, in common language, life. This principle is, perhaps, conceived of with more difficulty than any other in nature, which arises from its being more complex in its effects than any other; and it is therefore no wonder that it is the least understood. But although life may appear very compounded in its effects in a complicated animal like man, it is as simple in him as in the most simple animal, and is reducible to one simple property in every animal.*

* [It is considered by many, and perhaps truly, that we are not yet prepared for a generalization of so high a kind, or at least that it would be more convenient for the analysis of vital phenomena to consider life as made up of several principles differing in their nature.]

I have observed that animal matter may be in two states; in one it is endowed with the living principle, in the other it is deprived of it. From this it appears that the principle called life cannot arise from the peculiar modification of matter, because the same modification exists where this principle is no more. The matter abstracted from life appears at all times to be the same, as far as our senses and experiments carry us. If life arose out of this peculiar modification, it would not be destroyed until the modification was destroyed, either by spontaneous changes, as fermentation, or by some chemical processes; and were it destroyed by the last, it might sometimes be restored again by another process. Life, then, appears to be something superadded to this peculiar modification of matter; or this modification of matter is so arranged that the principle of life arises out of the arrangement, and this peculiar disposition of parts may be destroyed, and still the modification, from which it is called animal matter, remain the same. If the latter be the true explanation, this arrangement of parts, on which life should depend, would not be that position of parts necessary to the formation of a whole part or organ, for that is probably a mechanical, or at least organical, arrangement, but just a peculiar arrangement of the most simple particles, giving rise to a principle of preservation; so that matter so arranged could not undergo any destructive change till this arrangement were destroyed, which is death. This simple principle of life can with difficulty be conceived; but to show that matter may take on new properties without being altered in itself as to the species of matter, it may be not improper to illustrate this idea by such acquirements in other matter. Perhaps magnetism affords us the best illustration we can give of this. Iron appears at all times the same, whether endued with this property or not; magnetism does not seem to depend on the formation of any of its parts. A bar of iron without magnetism may be considered like animal matter without life; set it upright and it acquires a new property, of attraction and repulsion, at its different ends. Now is this any substance added; or is it a certain change which takes place in the arrangement of the particles of iron giving it this property? If we take a piece of glass, it is transparent; we break it into a thousand pieces and it becomes white. Whiteness is not a new matter added to it, but a property arising from its being composed of a number of small pieces.

It was not sufficient that animal matter should be endowed with this first principle, the principle of preservation, it was necessary that it should have action or motion within itself. This does not necessarily arise out of the arrangement for preservation; on the other hand, the arrangement for preservation, which is life, becomes the *principle* of action, not the *power* of action, for the power of action is one step further. The *power of action* must arise from a particular position of those living parts, for before *action* can take place the matter must be arranged with this view. This is generally effected by the union of two or more living parts, so united as to

allow of motion on each other, which motion the principle of action is capable of effecting when so disposed. A number of these simple acting parts, united, make a muscular fibre; when a number of these are put together they form a muscle, which, joined with other kinds of animal matter, as tendon, ligament, composes what may be called an organ. Thus, too, by the arrangement of the living particles, the other organs of the body are formed, their various dispositions and actions depending on the nature of the arrangement, for action is not confined to muscle, the nerves also have action arising from the arrangement of their living particles.*

The principle of life has been compared to the spring of a watch, or the moving powers of other machinery; but its mode of existence is entirely different. In a machine the power is only the cause of the first action or movement, and thereby becomes the remote cause of the second, third, &c.; but this is not the case with an animal; animal matter has a principle of action in every part, independent of the others, and whenever the action of one part (which is always the effect of the living principle,) becomes the cause of an action in another, it is by stimulating the living principle of that other part, the action in the second part being as much the effect of the living principle of that part as the action of the first was of the living principle in it. The living principle, then, is the immediate cause of action in every part; it is therefore essential to every part, and is as much the property of it as gravity is of every particle of matter composing the whole. Every individual particle of the animal matter, then, is possessed of life, and the least imaginable part which we can separate is as much alive as the whole.

The first, and most simple idea of life, I have observed, is its being the principle of self-preservation, preventing matter from falling into dissolution,—for dissolution immediately takes place when matter is deprived of it; and the second is its being the principle of action. These are two very different properties, though arising from the same principle, the first being capable of existing independently of the second; for it may be observed, that it is not necessary for the preservation of animal matter that there should be action in all parts, for many parts of an animal appear to have

* [This opinion concerning the unity of the principle of life has already been shortly adverted to. It may perhaps be illustrated by referring to the powers of common matter, which are not one, but many. There seems good reason for considering the different kinds of attraction as modifications of a higher principle, and the best reason for believing that magnetism, common electricity, and galvanism proceed from the same source, or at least are essentially identical; the same is highly probable in regard to the powers of life; in analysing physical phenomena, however, it is found far more convenient to consider the powers above mentioned separately, and it cannot be doubted that physiologists would derive equal advantage from pursuing a similar method. According to the author's representation, the modifications of life result simply from differences in the organised apparatus, through which it manifests its effects, nearly in the same way as mechanical force may be made to produce the most different effects, according to the kind of machinery which is employed.]

little action, yet they are as much endued with life as the more active parts; such, for instance, as tendons, elastic ligaments, &c.

A fresh egg is a body which, it must be allowed, has no vital action; yet an egg is as much alive as an animal, which I shall endeavour to illustrate by observation and experiment. I was led to this opinion in the year 1757, when I was making drawings of the growth of the chick in the process of incubation. I then observed, that whenever an egg was hatched, the yolk, which is not diminished in the term of incubation, remains sweet to the last, and that part of the albumen which was not employed in the growth of the chick was perfectly sweet some days before the hatching, though both had been kept at a temperature of 103° in a hen's nest for three weeks. But if the egg did not hatch, I observed that it became putrid nearly in the same time that other dead animal matter does.

To determine how far eggs would stand other tests of the presence of the living principle, I made the following experiments: I put an egg into a freezing mixture about zero, and froze it, and then allowed it to thaw. From this process I conceived that the preserving power of the egg must be lost, which proved the case. I then put the egg into a freezing mixture at 15° , and with it a new-laid one, to make the comparison on that which I should call alive, and the difference in the time of freezing was seven minutes and a half, the second one taking so much longer to freeze. 2d. I put a new-laid egg into a cold between 17° and 15° ; it took about half an hour to freeze: when thawed I put it into an atmosphere only at 25° ; it froze in half the time, which it should not have done, nor even in half an hour, if had not been killed by the first experiment, for the atmosphere now was not so cold as in the first experiment by nine degrees. These experiments show that the egg, when living, has a power of resisting cold, which, when killed by freezing, it has not.

To determine the comparative heat of a living and dead egg, and to determine whether a living egg be subject to the same laws with the more imperfect animals, I made the following experiment.

I took a fresh egg, and one which had been frozen, and put them into a cold mixture at 15° . The thawed one soon came down to 32° , began to swell and congeal: the fresh one sunk to $29\frac{1}{2}^{\circ}$, as happens to living animals, and in twenty-five minutes after the dead one froze. Another reason for supposing it dead was, that before freezing took place it rose to 32° , as other fluids do which are brought below their freezing point.

From these observations and experiments, it must appear that a fresh egg has a power of resisting heat, cold, and putrefaction; and similar results are come to by similar experiments on some of the more imperfect animals, which we shall have occasion to notice hereafter.

It would appear, then, that life is not *action*, but it is continued or supported by it when it takes place. Action creates a necessity of

support, and furnishes it. It is not necessary that *action* should continue in all parts; in some it is only necessary that the principle and power of action should be continued, but in others it is necessary that *action* should take place even for the preservation of the principle of action. Action is necessary for the various purposes for which the animal is intended, and if one species of action takes place, it brings the whole into action, as all the parts and actions of an animal body are dependent upon one another. If the heart acts, the lungs must fulfil their part; the stomach must digest, the other parts subservient to this organ must be put in motion, and the secretory organs, nerves, and voluntary muscles. The whole is thus set in motion to produce some ultimate effect, which appears to be the propagation of the species, for preservation (of the individual) cannot be called the ultimate effect.

I have asserted that life simply is the principle of preservation in the animal preserving it from putrefaction; but there is a curious circumstance attending life which would appear to be contradictory to itself. Life is the preserver of the body from putrefaction, and when life is gone putrefaction would appear soon to begin. But this is not uniform; it is sooner in some cases than in others; therefore there must be some other cause than the simple deprivation of life to account for this difference of time. In the most striking instances of rapid putrefaction after death, it does not appear to arise from the process of putrefaction having gone to some length before total death took place, for in those who die of putrid fever the smell becomes less offensive before death, and when life is gone they do not go into putrefaction as soon as might have been expected, and not nearly so fast as many who had not the least tendency this way before death. The tendency to putrefaction in those whilst living would appear to be part of the disease, but does not become putrefaction, and on dying they appear to lose that tendency, and to become like other bodies. However, it is disputed whether, in putrid fever, there is really any putrid matter formed.*

But there is a process or an action in life which predisposes the body for many diseases, and which becomes the remote cause of them; and there is an action in life which disposes the body for a species of putrefaction (or decomposition) when dead, and very probably death is the effect of this action in these cases. In these cases the body immediately after death becomes emphysematous; this emphysema, though it does not occur during life, would yet appear to be an effect of life, for it depends on disease as the body is dying. It is not genuine putrefaction; for, when the process is ended, the body keeps nearly as long as if no such process had taken place. It occurs immediately after death, or perhaps in the act of dying. The process itself seems to continue when the body

* [The offensive exhalations here alluded to may probably, in great part, be referred to the excretions, which show a great tendency to run into rapid decomposition.]

is warm; after a time it stops, and the body remains stationary, until it sets out, as it were, for a second time to become putrid. What diseases this is to be classed with I do not know. To ascertain the causes of it with precision, it would be necessary to know the persons when alive, the disease of which they died, and the time when the putrefaction occurred after death. I have myself seen several very remarkable instances of its occurrence. The first was that of a young lady about four months gone with child, who in March or April, about two or three in the afternoon, was suddenly taken ill with a fit, of which she shortly died. She was opened the next morning at seven o'clock, when the body was found swelled with air extravasated in the cellular membrane; the mesentery, intestines, liver, and heart were loaded with air, the blood worked out of the larger vessels mixed with air, and the body had become very offensive.

Another case of the kind occurred at St. George's Hospital, in a man who had an encysted tumour in the upper belly of the right rectus muscle, which contained a fluid: it was opened on Friday, and on the Monday following, in the evening, he became ill, and died at one o'clock. He was opened seventeen hours after death, and was found emphysematous, just as in the former case.

This appears to be similar to what is commonly termed sphacelus, being a species of mortification occurring before death, or in the act of dying.

That the mode of dying assists the process of putrefaction is evident in common mortification, which will be noticed when on that subject, and I may illustrate it further by relating what took place in a case of operation for aneurism.

A man at St. George's Hospital had the operation for popliteal aneurism performed. The artery was tied just where it passes through the tendon of the triceps muscle. The case went on well till the sixth day, when ulceration took place in some part of the artery which was not united: considerable bleeding took place, and recurred several times afterwards, by which so much blood was lost as to become in the end the cause of death. Immediately after the first bleeding, I observed the foot and leg of the diseased side to become cold as high as the middle of the calf, while it was warm about the knee, ham, and upper part of the leg. The lower part of this leg ever after remained cold, and did not in the least change in appearance, from which I conjectured that it was *dead*, not *mortified* (for there is a material difference). I suspected it was *dead* as in common death. He became weaker and weaker every day, and died about four days after. Before he died, the upper parts of the leg, which had gone on with life a little longer, were mortified, that is, they showed evident signs of such a change taking place; a vesication formed, discharging a bloody serum, and they became darker, as if blood was diffused in the cellular membrane, and œdematous, or, rather, emphysematous. A very short time after death these parts became putrid, while the lower part of

the leg and foot remained unaltered as in common death. Here was a part which just died for want of circulation, therefore no action took place in that part; but above, where there was action, a very different change took place, producing a tendency to putrefaction after total death had taken place. The part which died naturally without any action did not become putrid, while the part in which that peculiar action took place became putrid directly, though it died later. I took off the two *feet*, to see which of them would become putrid first; for some time it was difficult to perceive any difference, but about sixteen days after, the foot on the sound side began to turn green, and went on to putrefy much faster than the other.

The whole of this part of the case is extremely curious. First, that part of the leg which retained life longest became putrid immediately after death, because during life it took on actions which were productive of putrefaction. The foot of the diseased side, which died early, was not allowed time to take on any actions while living, excepting perhaps that resulting from the stimulus of death, and did not become putrid so soon as the foot on the sound side, which may be said to have died a natural death, and which died later. This I think may be accounted for by supposing that the latter, from surviving some time longer, took on some of those actions which gave the tendency to putrefaction. It may be necessary to explain what I mean by the stimulus of death. Death itself produces an action in all the muscular parts when there is nothing to prevent it. If a man's head be cut off, he becomes stiff; he is not stiff while there is real life: for there is a difference between visible life and real life. A part may be living though not in action; but whenever death takes place it excites an action in every part that is muscular: they contract, and this is the action of death. To cease breathing is not the action of death, though certainly it is the first step towards it, and gives rise to the other. The action of real death is that which takes place in the stiffening of the body, and till then it is not dead (except when killed in a peculiar manner—killed universally before the stimulus of death can be given,—and then it remains lax).

I suppose, then, that this foot, which died first from the loss of blood, became stiff; that is, took an action resulting from the stimulus of death, all the muscular parts contracting;—that in the other foot the stimulus of death was in some measure lost, from the longer continuance of the diseased state, and the consequent action was less strong. What would be the consequence of this? I take a man in perfect health, and cut off both his legs; to one I give a stroke of electricity sufficient to kill the part before it contracts, and no contraction takes place; the other I leave to itself and let the stimulus of death produce contraction: this latter shall not become putrid so rapidly as the former.

CHAPTER III.

THE BLOOD.

Reasons for its fluidity;—erroneous views respecting its nature.—Animalization and vivification two distinct steps in the conversion of foreign matter into part of a living body.—Blood not merely fluid animal matter;—has also become vivified;—arguments for this opinion.—Coagulation of blood;—its importance in determining the nature of blood;—varieties in the process.—Case proving the life of the blood.—Death of the blood preventing coagulation.

WHAT I have had hitherto principally in view has been the solid animal matter, its formation, and its arrangement by which it is endued with life, composing, as it were, the whole visible body. The fluid part of the compound now remains to be taken notice of.

Blood is the material out of which the whole body is formed and out of which it is supported.* It is fluid that it may be capable of moving to the very minutest part of the solid with ease, and may with less difficulty be divided for the increase and repairs of the different parts of the machine; easy of division and separation, to form various secretions, and also to bring back what was superabundant, and to carry off the parts which were useless.

This part of the body has been considered as a passive, inanimate, moving fluid, found everywhere in the body, deriving motion from the heart for the various purposes of the whole, then returning to the heart to be sent out again. Those who have formed this idea of the blood have no adequate notion of the manner in which it is capable of performing those great uses above mentioned. Some, in considering this fluid, have been in a great measure satisfied with examining the spontaneous changes which it undergoes out of the circulation. This might have led them to draw some natural conclusions, since all natural phenomena are facts, and teach enough of a thing to enable us to draw sound conclusions. Others have attended to the chemical analysis, which teaches nothing with respect to its use in the living body; for blood gives no analysis excepting that of common animal matter.† Some inquirers have laid great stress on its appearance when viewed with a microscope, as if forms of parts would explain first principles: this they cannot do unless in operations that are mechanical. This inquiry could

* [The expression of Bordeu is peculiarly elegant: "*Le sang est de la chair coulante.*"]

† [This observation is no longer true. Some important additions to physiology have of late years been obtained from chemical investigation of the blood with the present improved means of analysis; and with further improvements we may expect still more light to be thrown on the subject. The subject will be more fully considered when the 'Treatise on the Blood,' &c., comes before us.]

be carried no further than to investigate such parts of the blood as have form and opacity, if there are such, and that which appears to have both is called red blood: in a great number of animals, therefore, the knowledge of the operations of the blood in the animal body rests nearly in the same state that it did some centuries ago. The two last points of investigation, namely, the chemical analysis of the blood and the form of the blood globules, though very proper to be made by physiologists, have hitherto explained nothing in the animal economy.

Before I explain my opinion of the blood, it may not be improper first to state some facts from which I draw my conclusions.

I have endeavoured to show that animal matter differs from common matter in many circumstances; that this animal matter has a principle peculiar to itself, which I call *life*, and this life is the second step or process of animal matter. Animalization is the first; vivification the second. To prove this, I observed that an animal is increased and supported by many substances, which previously had not the properties of animal matter, and of course not the principle called animal life; I observed, too, that it was also supported by substances which were of animal origin, but which had not then the living principle; in other words, an animal can be supported on dead vegetable and animal matter. In the next place it was remarked that these substances, before they can increase or support the animal, must all be converted into animal matter; and lastly, that the substances must be so prepared, or animalized, as to become part of the body, and of course to be endued with the living principle.

It is now necessary to trace these changes in the food till it becomes part of our solids, and observe as we go along when it is most probable that life begins.

Blood is not simply fluid animal matter, it is animal matter particularly arranged, for it differs in every respect from fluid animal matter produced by art. The first change that takes place with vegetable matter before it is rendered blood is its conversion into animal matter. This change I call animalization. With animal matter it might be supposed that no change was necessary to produce animalization; but we find the change, whatever it may be, the same in both; and the process in both is probably similar, for the produce from the digestion of animal matter is as different from common animal matter as anything can be: were it not so, animal substances rendered fluid by chemical operations, as jellies, &c., would answer the same purpose as blood. But the necessity for a total and similar change in both is evident, for out of this change life is to arise, digestion being the first step towards vivification. It may be supposed that the first step in the digestion of vegetables is that of animalizing them, and that they go through the next of chyfication with animal matter; but this we cannot allow, for it would be supposing two different actions going on in the stomach at the same time, which I should very much doubt.

The second process, vivification, must take place somewhere before the blood becomes an active part of the machine. We shall first premise that animalization may take place without vivification,—(how far this is the case is not easily determined,)—however, we may say with certainty that vivification cannot be prior to animalization. Let us first trace animalization.

Animalization begins in the stomach, and in common language is called digestion, the immediate produce of which is called chyle. In the change of food into chyle we do not see why it may not have received the living principle, for the change is such as renders it capable of becoming alive. But it may be supposed that this process is reserved for the lungs, where the chyle is so much exposed to the air: the air may be imagined to act on it like heat on an egg, or moisture and warmth on seeds, giving a power of growth to their particles. In these cases, however, it is not the principle of life which they give; they only give life its action.

Again, blood may be supposed not to become alive till it be made into a solid, when it becomes part of our body, and loses the property of blood, and there its life is indisputable; but I am apt to believe that the living principle takes place sooner, which I imagine will appear in investigating the properties of the blood, with the many phenomena that attend it in the living body.

I have already observed that the organization of animal matter is not necessary for life,* only for its actions; therefore fluidity is no objection to the blood being alive. My reasons for supposing the blood to be alive in a fluid state are the following: 1st, It may be observed that it appears to carry life to every part of the body, for whenever the whole or a part is deprived of fresh blood it very soon dies. This blood, however, must be such as has undergone some change in the lungs; for if the blood did not undergo this change it would probably soon die, therefore would not be capable of keeping up the living principle in other parts. This effect arising from the want of fresh blood is so evident that it needs no illustration; I may therefore conclude that it is the only cause and support of life, the nerves having no other part in it but to produce some of the actions,—not life itself, for without this support the nerves themselves die. 2dly, We may observe that whilst circulating, or in useful motion, it is always found in a fluid state.—Hence I think I may be allowed to say, as it is never found in a solid form in the cavity of the blood-vessels, that it has not the least tendency to become solid; that such a state is contrary to its nature.

* [This has ever been a *quæstio vexata* with physiologists, and will probably long continue so. The instance of the egg which has been already adduced, and of the blood, which now comes under consideration, were supposed by Mr. Hunter to demonstrate the existence of vitality *independently* of organization. Although, however, the fact of the vitality of the blood and of the egg should be admitted, it yet remains to be proved that the globules of which they both appear to consist do not present incipient traces of organization; but the question is not one which can be entered into here.]

This must arise from some principle which is probably both in the blood and the vessel. The want of disposition to coagulate whilst moving in the living vessel does not arise from the motion, for in many places where the motion is extremely slow the blood remains fluid. We have instances of this in the veins of the leg, where the crural artery has been tied, in which case the blood only moves through a few small collateral branches below, and back again by the larger veins. Now, a small quantity of blood being sent into these larger vessels, the motion in them must be next to stagnation; yet, while there is any degree of motion, the irritation of imperfection is not given: there is consciousness of its being an useful part; by which is meant that the harmony between the solids and fluids is kept up. It is curious often to see the small quantity of motion which shall keep up this mutual harmony. In cases where people have been days, or even weeks, in trances, where there is not the least perceptible motion in the blood, it has retained its fluidity, because both solids and fluids retained their life, though not their actions. The want of disposition to coagulate in such situations does not arise from any property in the blood simply as animal matter, for simply as animal matter (whose alterations arise out of its composition, as fermentation,) it would not vary in its effects from circumstances that do not in the least alter the nature of the compound.

Dead animal matter acts on the living body as any other foreign or extraneous matter; therefore, the blood being in perfect harmony with the living principles of the solids when both are in perfect health, is a presumption that the blood is alive. However, this argument is not conclusive, for we find in the blood heterogeneous parts which do not destroy this harmony: most probably those heterogeneous bodies are introduced simply as stimulants to the living principle, as extraneous objects are to the sensitive.

This harmony of the blood with the solids is more observable in some parts than others. The parts with which it is in the greatest harmony are the vessels; this is evident from its retaining its fluidity longer in contact with them without motion than in any other part of the body, though equally inclosed in living parts.

All the diseases which act on the solids act on the blood, causing it to effect those changes which arise spontaneously from rest out of the body; so that blood is as capable of diseased *actions* as the solids are. If the blood did not change in the diseased states of the solids, it would lose the natural harmony I have been speaking of. This change is according to the state of the solids, which shows the intimate connexion between the two; it is not primary diseased alteration of the fluids, but a consent with the diseased disposition of the solids.*

* [How far the blood can originate an *action* within itself, for the purpose, as it were, of bringing itself into harmony with the changed condition of the solids is a question which I think will generally be answered in the negative. That the blood *does* harmonize with the solids is an incontestible fact; but then the

On the other hand, the solids are affected by diseases of the blood: I even suspect death in the blood can take place independently of the solids; but the death of the solids will soon follow.

The blood when at rest has a disposition to separate into several parts, viz. coagulable lymph, red particles, and serum; the red part being retained in the coagulable matter, and the serum squeezed out in the act of coagulation. This disposition in one of the parts to coagulate when at rest, from whence the above changes are produced, is more or less strong, according to circumstances.

This property of the blood deserves particular attention, as it throws more light on its nature than any point of view in which it can be considered, it being spontaneous and natural. It is by this change that the solids are formed, and it seems to me so important that I think it almost the only thing necessary to be considered more fully; indeed the power of coagulation in the blood throws so much light on the nature of a disease, so far as the blood is concerned, that it is almost the only part we have recourse to in the examination of the blood after bleeding, when we look to see whether or not the blood is buffy, that is, whether there has been a disposition for the red globules to sink faster in such blood; or rather, perhaps, that from such blood being longer in coagulating, the red globules have time to sink to the bottom, and leave the coagulable lymph at top free from red globules, and this causes the buff of the blood.* It is by this coagulation also that we perceive whether the blood is cupped or not, that is, whether the coagulum draws

cause of this harmony is in the solids themselves, either directly by an impression communicated to the blood by the vessels, or indirectly from some defect in the processes of nutrition and sanguification; some retention or vitiation of the secretions; some introduction of deleterious matter, or some fault in some one or more of the vital actions. According to Mr. Hunter's own definition (p. 28), action requires organization, and yet the great difficulty which he is even now combating is, how the blood, an *unorganized* fluid, should possess life. In short, there is the strictest kind of reciprocity between the solids and fluids; not, however, arising as parallel effects, but as cause and effect; the solids, being altered, necessarily modify the blood, and the blood, being modified, as certainly reacts upon the solids. In this point of view, to employ the words of Andral, "On ne trouve plus de sens aux disputes des solidistes et des humoristes; l'économie ne paraît plus qu'un *grand tout*, indivisible, dans l'état de santé comme dans l'état de maladie."]

* [The buffy coat is undoubtedly mainly due to the cause which Mr. Hunter has assigned. Dr. Davy, however, has remarked, and I think the observation will be borne out by the experience of every one, that this phenomena is sometimes exhibited, even in a marked degree, although the coagulation shall have taken place more rapidly than usual; nay, a bluish and transparent lymph may often be observed to have separated from the other parts within thirty seconds after the blood is drawn, and consequently much sooner than under ordinary circumstances. There seems, therefore, reason for believing that the buffy coat is referrible in some measure to a greater relative difference in the specific gravities of the coagulable lymph and red globules than natural, as well as to the slowness of the coagulation. Mr. Hunter partly also accounted for the appearance of buffy blood, by supposing that "the blood has an increased disposition to separate into its component parts;" a supposition which I cannot but think is borne out by many facts.]

together and its edges rise; and then we say that the blood is not only inflammatory, but highly so, showing great strength in the constitution: if, on the other hand, it lies flat in the cup, and makes an even uniform surface, we know it is rather loose in its texture (although it may be still buffy), which shows that the powers of the constitution are weak.

The red globules abstracted, or the red blood abstracted from the other parts, need hardly be considered, as they hardly explain anything.

The serum also explains but very little; there may be more or less of it than common, but in itself it explains very little.

The power of coagulating in the blood is greater when out of the circulation and exposed to common air, even more than when extravasated in some cavities of the body, the necessity or use of which is evident, for by this it becomes more effectual in stopping extravasation. A striking instance of this kind happened in the crural artery of a boar. I cut it through and allowed it to bleed; but before the animal became weak, or at least had the appearance of weakness, the bleeding became less and less, till at last it stopped. On examining the artery, it was found to have a quantity of coagulated blood opposing and surrounding its cut end like a mop, through which the blood could not pass.

This power of coagulation, especially when exposed, enables the blood to unite external wounds more readily, and of course preserves the living principle better, and keeps the internal parts from exposure in many wounds which otherwise would become external: by this means they are united by the first intention.

In all inflammatory dispositions in the solids, whether universal or local, the blood has an increased disposition to separate into its component parts, the red globules become less uniformly diffused, and their attraction to one another becomes stronger, so that the blood when out of the vessels soon becomes cloudy or muddy, and dusky in its colour, and when spread over any surface it appears mottled, the red blood attracting itself and forming spots of red. This is so evident in many cases that it is hardly necessary to wait till the whole coagulates to form a judgment of it. I think I can say when the blood is coming from the vessel, by its appearance in the stream, whether it will be sily or not. When the blood has not an inflammatory disposition, the stream has a degree of uniformity and transparency in its appearance; but it is only an eye accustomed to it that can make this distinction.

If the inflammatory disposition of the solids arises from fever, this disposition in the blood is universal. If there is universal inflammatory disposition, from some local irritation, the blood is still universally affected. But if the inflammation is local, and the constitution is not affected, the disposition in the blood is not universal: how far there is local inflammatory disposition of the blood I do not know, but there is reason, however, to suspect

it, from the ready union of parts under inflammation. If the blood does become inflamed in passing through an inflamed part, we must suppose that it immediately loses that disposition when it meets with parts in perfect health.*

These properties, namely, increase disposition to separate, and a disposition to become a firmer solid, always show increased disposition for action in the living principle, and also, most probably, increased power. It is one of the signs of strength of the living powers although the materials for action are weak.

The use of this change in the blood is evident, since it is made fitter for uniting parts by this means; and it is from this disposition that the blood retains its living principle sufficiently long till union takes place. Unless the stimulus of necessity for coagulation is given by the solids, the extravasated blood will not coagulate, it will only act as an extraneous body, which often happens where union is unnecessary, improper, or hurtful, as in cases of contusion where the blood remains fluid in the cellular membrane.

This disposition to coagulate when out of the vessels, or when retained in them without motion till the consciousness of the use of motion, and of course of fluidity, is lost, in one of the effects of the life of the blood.

I have used the word *consciousness* because we have no language existing answerable to all my views of the animal economy, and to coin words would not answer the purpose, because then I must have a dictionary of my own. I have not a word for expressing the cause of those actions which take place in the body, as if it was conscious that such and such things were going to take place. There are actions in the body which come the nearest to consciousness of the mind of anything that I can conceive, and therefore I make use of this word; but it is commonly applied by philosophers only to the mind.

Coagulation is a species of attraction arising out of this irritation.† It may be considered as a species of generation, for it is

* [That the blood undergoes peculiar changes, losing its globular character, its transparency, and the vividness of its colour, as well as its motion, in the vessels of inflamed parts, it is evident from the observations of Levret, Kaltensbrunner, Dollinger, and others, who have microscopically investigated this subject. These changes are most likely due to the influence of the vessels upon their contents; but to suppose that the blood itself can be the subject of inflammation, is to suppose it endowed not only with life and organization, but with life and organization of a high degree, for from the best observations which have been made it does not seem probable that those animals which are lowest in the zoological scale are capable of inflammatory action. Certainly we can form no definite idea of inflammation, except as connected with vascular and organised parts, although, from what is said further on, Hunter did not carry his ideas of the blood to that extent.]

† [Hunter uses the term *irritation* in place of the *exciting cause*. His meaning, therefore, seems to be that the *consciousness of necessity* is the *exciting cause* of coagulation, or that coagulation arises from the *irritation* of this *consciousness*. This is an instance of false logic, or of reasoning from final causes, which he

the first action or establishment of a power of action within itself, so as to form itself into muscular fibres, the only powers in an animal; these, again, with other parts, form organs to act on the materials from which they arose, for their own support.

I will relate a case in proof of most of the arguments which I have employed respecting the life of the blood. It is one of many.

A man came to St. George's Hospital who had a hydrocele, for which he was tapped with a lancet. The water was clear serum: when this was evacuated, the testicle to the feel was found to be larger than natural. About a month after, the tunica vaginalis became as full as before; the radical cure was now determined on, the tunica vaginalis was slit up its whole length, and the fluid, which was now bloody, was evacuated. The testicle, on being exposed, was found larger than natural, and was extracted. On the body of the testicle, and nearly in the direction of its long axis, and opposite to the orifice in the sac made by the lancet when the water was first evacuated, lay a coagulum of blood, dark in colour, almost like a leech when that animal is shortened, about two inches long, and of the thickness of a common sized little finger. In the angles between the epididymis and body of the testicle lay another coagulum, adhering in some places to the epididymis, in other parts loose to the body: it was attached only at one end. The adhesions of the large coagulum to the body of the testicle were firm, although it would admit of separation. This was made at one end, when fibres were plainly seen running from the testicle to the coagulum. The adhesion of the small coagulum was in many parts still firmer. All over the tunica vaginalis there were a great many vessels full of blood, and in many parts coagula of blood-like extravasation. In this state I had a drawing made of it, and a small part magnified, to show the vessels and the dots of extravasation as they then appeared. By being put into water all these vessels and dots disappeared, and the parts became white. I then injected the testicle by the spermatic artery, which succeeded extremely well. On examining the part I observed the following appearances. The surface of the testicle and tunica vaginalis had resumed the former appearance, only with this difference, that the injection was of a lighter red than the blood to the naked eye, and much more so to a small magnifier. The vessels on the surface were very distinct, and the dots, where the extravasation of injection was as if there had been extravasation of blood. The coagulum on the tunica vaginalis now appeared vascular; the surface of the adhesion, for about one twentieth of an inch, was injected and extremely full of distinct vessels. The smaller coagulum was injected

not unfrequently displayed: he has described the objects to be attained by coagulation, and he here states that the necessity of affecting these objects is the cause of the coagulation, which is much the same as to say it is so, because it is so. It is evident that this does not in the least help us to discover the proximate causes of coagulation.]

in many places through and through its whole substance, in the other only for a little way.

If it should be asked, How came those coagula there? The answer is the blood from the wound made by the lancet in the tunica vaginalis passed into the cavity, and then coagulated on the testicle directly opposite to the wound, and a small quantity of the blood which got down to the chink between the testis and epididymis coagulated there also. That this is the most probable way of accounting for it is, I think, strengthened by another case, where the tunica vaginalis was found adhering to the testicle, when performing the radical cure, at the very part where he had before been tapped. In half a year probably this coagulum would have become wholly vascular, and probably in a little longer time the whole would have been taken away; because, being vascular, it would have had absorbents, which would have taken it all, as a useless part, into the constitution.

The tunica vaginalis filling again so rapidly in this case was perhaps the reason why it did not adhere to the coagulum on the other side, so as to produce a union between the two parts.

Quære, For what purpose did this coagulum become vascular? * for no visible purpose could be answered by it, as absorption, we may suppose, might have taken place as easily in a coagulum as in the cellular membrane. But perhaps absorption not going on here was the cause of the collection of water; and adhesive inflammation evidently took place here that it might be able to absorb itself.

Thus, then, the materials of which the blood is composed are joined with the living principle: in consequence of which the blood, if properly disposed, is capable, when extravasated, of forming itself spontaneously into parts fit for motion, and for performing all the offices of any part of the living whole, successively receiving the stimulus of nature from the surrounding parts to form itself into a similar part, as bone, cartilage, &c.

In many diseases not inflammatory, namely, those called putrid, where the solids have a tendency to fall into those changes natural to animal matter deprived of its preserving principle, the blood has no disposition to coagulate, nor the solids any power of raising

* [The opinion that coagulated blood can become vascular, and so afford the common basis of union by the first intention, was firmly entertained by Mr. Hunter; but the proofs which are here adduced in favour of such an opinion are by no means so conclusive as they should be to establish so important a doctrine. For, not to mention the length of time which elapsed, in the present cases, between the injuries received and the appearances observed, the situation and definite form of the coagula would rather favour the idea that they proceeded from effused lymph, which became more or less intermixed with effused blood. Such an intermixture is generally observed in cases of wounds and operations, but I am not aware of any unequivocal example of pure coagula which have been observed to become vascular, although it is scarcely possible that this should have escaped observation if it were at all frequent. See Plates I. and II. for the appearance alluded to in the text.]

inflammation, both having taken on the same disposition. In such a disease both the principle and power are diminished, so that life is hardly able to preserve the matter from falling into its natural changes, though it has still a disposition to keep the vital parts or body moving.

Many kinds of death as well as putrid diseases produce this effect on the blood: an instance of which was met with in a gentleman, who being in perfect health, died instantaneously from passion, this having been so violent as to produce death in every part at once, and his blood did not coagulate.

A healthy woman was taken in labour of her fourth child. As the child was coming into the world the woman died almost instantly. On opening the body next day, there appeared no cause for death whatever, every part being natural and sound; but the blood was in a fluid state, nor did it coagulate on being exposed.

A soldier, a healthy young man, confined for desertion, received a blow on the pit of his stomach from one of his comrades, from which he dropped down, and died almost instantly. On opening the body, no preternatural appearance was observed, but the blood was in a perfectly fluid state, and did not coagulate when taken out of the vessels and exposed a considerable time.

In animals struck dead by lightning the blood does not coagulate nor the muscles contract, both being killed at once.

There are other instances. Two deer were hunted to death, in which case they acted until the very power of action ceased, and of course death ensued. On opening them the blood was fluid, only a little thickened, and the muscles were not rigid, as we find them, where they are capable of acting, from the stimulus of death. In both cases the life of the solids and of the blood was destroyed at the same time and at once.*

The observation that animals hunted to death are tenderer than those killed by other means, is not uncommon.

There is a natural action of the living body which destroys the life of the blood in the act of extravasation; this is the discharge of the menses in women. If that discharge is natural and healthy, the blood does not coagulate; but, on the other hand, if the extravasation is not a healthy one, the blood coagulates as it is extravasated, and comes away in clots. This perhaps is best demonstrated in cases where the hymen is unperforated and the menses are accumulated. This observation leads us to understand

* [The diversity of circumstances under which the blood remains fluid after death at present renders any generalization upon the subject impossible. This is so much the case that many able physiologists of the present day are disposed to ascribe the incoagulability of the blood to a cause the very reverse of that assigned by Hunter, viz. to a greater residual vitality in the blood and vessels than in ordinary death, by virtue of which the fluidity of the blood is preserved until the disposition to coagulation is lost. But this explanation, like the former, explains only half of the cases. See Notes to the Treatise on the Blood and Inflammation.]

something of the nature of the menses ; for, depend on it, where a woman has her menses come away in clots, it is not a natural but a diseased discharge.

To prove that the blood and the solids correspond very much in their actions of death, we shall only generally observe, that when an animal dies in the common way, it is by the vital actions being first destroyed ; but life still exists, for the muscles contract and the blood coagulates. But if we destroy life instantaneously, or along with the vital actions, then the muscles will not act, and the blood will remain fluid.*

These changes in the blood, which appear spontaneous, are not really so ; they arise from irritation in the blood itself as much as any actions in the solids. This irritation excites the natural action of the blood, which produces these effects and all the properties we see the blood possesses in either a healthy or diseased state.

We cannot suppose the blood has a power of communicating sensations, as it cannot have nerves ; its living powers are therefore those of simple life, and it is similar in that respect to the solids of many animals.

As sensation is a principle superadded, and intended to convey fixed intelligence, it is necessary for a moving part to have it ; but when it becomes a fixed and solid part it opens a communication with the mind.

Thus far I have endeavored to show that the blood is as much endued with life as the solids are ; and the only difference between the two is that the solids have construction, called organization, producing considerable visible effects, while the blood, not having this construction, does not produce these visible effects. The truth of this theory will appear more evident in treating of the diseases of the animal body.†

* [In Bichat's language, the animal life dies first, and after that the organic life. The muscles stiffen by organic contractility.]

† [The reader will form a better idea of the greater copiousness of the present copy of Lectures as compared with Mr. Parkinson's "*Reminiscences*," when he is informed that the whole of the preceding pages are comprised in less than seven pages of the latter. The consideration of the blood is less fully entered into here than in the Treatise on the Blood and Inflammation ; but the reader will not fail to observe that Mr. Hunter often speaks with less reserve on many points in the former than in the latter ; although in judging of his opinions, those contained in the Treatise on the Blood should undoubtedly be preferred, as being the result of his last and most deliberative judgment.]

CHAPTER IV.

ORGANIZATION AND ACTION.

General views of organization and action.—Arrangement of matter into certain forms to answer the end required ;—these structures combine to form organs ;—organs arranged according to certain laws constitute animals.—Organization and life distinct from each other.—Action exists in every part of an animal ;—depends on contractility.—Of two kinds ;—common—and peculiar.—These are mutually dependant ;—of the first kind, all involuntary ;—of the second, nearly all so ;—cessation of the latter in disease ;—Mr. Hunter's own case.—Of the second, digestion, circulation, and respiration are most closely connected with the first ;—others, as motion of the limbs, more distantly.—Motion may be caused by elastic forces reacting, as in ligaments.—Conclusion.

FROM what I have said above, it must appear that original or common matter has been first so decomposed, and then again so combined, as to become animal matter. This animal matter next became so arranged as to become alive. Now I shall observe that these combinations and arrangements are differently modified, so as to produce the various kinds of animal substances ; some of which have their parts so disposed as to have motion among themselves, as muscles ; others to have sensation, as brain and nerves ; and in others the living parts are so disposed as to acquire other properties, as elasticity, rigidity, &c.

Solidity, in a certain degree, is necessary for self-motion ; for parts cannot produce motion in one another without some resistance or fixed point of motion. We therefore find the acting parts of an animal composed of solids, or the parts which compose them could not coalesce together by the attraction of cohesion ; and it is necessary that it should be so, as without this no determined action could be produced.

Now we have gone so far with the materials of an animal, let us next examine how these materials are disposed so as to form an animal. These materials may now be considered in a mechanical point of view, like the component parts of a machine, each of which has its destined use and own peculiarity of form. These are united with each other to form parts, the whole forming organs of various kinds to produce the mechanical effects required. These organs, again, united according to certain established rules, form animals. This compounding of animal matter is what should be understood by organization.

Now if this idea of organization is just, organization and life are two different things ; for, according to this definition, a dead body is as much organized as a living one, for in the dead body the same mechanism exists as in the living one.

Organization, then, comes nearest our ideas of the mechanical

formation of parts, and the ultimate effect must be mechanical ; for it is impossible to produce motion in matter without having a mechanical effect.

Having considered simple life, and the general idea of what is called organization, we shall next consider *the Actions of an Animal*.

We have said that animal matter is so constructed as to be endued with a power of self-motion, as in a muscle ; and as we can hardly conceive any part of an animal entirely passive or free from motion, since all parts grow and are nourished, we must suppose this muscular structure very universal in an animal body, though this power has been considered principally in regard to muscles, properly so called, whose actions are plainly visible to the eye.*

The different necessary circumstances attending the composition of a muscular fibre, with the mode of action of a muscle, we shall not touch upon, the field being too large for my present purpose. I shall only observe that they are the animal powers by the immediate actions of which every, the smallest, part of an animal is moved.†

Every machine has its power ; a clock has either a spring or weight, and so on. In mechanics the parts are dependant on one another, so that some *one* power is necessary to put the whole in motion ; in mechanics too there is commonly but one ultimate effect produced, whereas in an animal body there are a thousand. The powers therefore of an animal body are differently placed and circumstanced from what they are in an inanimate machine : it is not one power that is setting the whole to work, because if that were the case an animal's actions would always be the same, but he is at rest in one part, moving in another, and so on ; and as this is the case, he must have power in every part, so that his powers are diffused through the whole animal, which is almost composed of powers.

The actions of an animal, considered as a whole, should be divided into two kinds. 1st, Those actions common to every part alike, such as those which are employed in the internal operations of the machine, as growth, alteration, building up, taking down, &c., every individual part (the smallest conceivable‡) acting for

* [The author has elsewhere (see *Introd. to Inflamm.*) defined life to be that power which renders the body "susceptible of impressions which excite action ;" a definition which, however brief, exhibits in miniature the leading features of Bichat's celebrated hypothesis, according to which all the actions and phenomena of life are ultimately referred to two primary principles—namely, sensibility and contractility.]

† [The reader is referred to Mr. Hunter's Croonian Lectures on Muscular Motion, in the *fourth* volume, where will be found a more full account of this subject.]

‡ [It seems now to be generally admitted by microscopical observers that even the globules of the blood possess an inherent power of motion, in their quality of organized parts. Wolff, Dollinger, Treviranus, Kaltenbrunner, &c. have noticed a variety of movements of this kind, which are principally of a rotary or volvular kind. See *Revue Med.* vol. ix. 1828, and *Journ. des Prog. des Sciences Med.* vol. viii. 1828, and also the *Treatise on the Blood and Inflamm.*

itself only, which actions may be called immediate. These are probably performed by the ends of vessels, whether the terminations of arteries or the beginning of absorbents; likewise the actions of the brain are of this kind. 2d, Those actions which are of whole parts, and which vary according to their composition or construction, being employed chiefly respecting other matter, not for the immediate use of themselves, as in those above mentioned, but still absolutely necessary for the first. These actions are of whole parts, as the stomach, heart, organs of respiration, organs of sensation, mind and will. That these actions differ from the first is evident, because the organs in which they are found have also the first, and are indebted to the first for their existence, in the same way that the first are indebted to the second for their continuance: the stomach, lungs, heart, and other organs of life, may be said to be continually supplying materials with which the first are employed in building and repairing the system. The second kind may be called labourers, being subservient to the first, which, as being engaged in laying down and taking up parts, may be called the bricklayers. It is the first which compose the movements of the true animal, being those which are immediately employed about itself. It is the operations of these which properly constitute the animal economy respecting itself, and it will be principally these which I shall consider.

The whole of the first kind of actions are involuntary, the will having no power over them, the mind being not even conscious of them, although it has involuntarily considerable influence over them under circumstances of diseased and irregular action. Most of the actions of the second kind are subservient to the first, and are absolutely necessary to the continuation of their existence. These have therefore a certain degree of regularity, and according to the relationship or immediate necessity of the second to the first are these second permanent and constant: indeed we seldom find in them any intermission, perhaps never in health; however, in disease they are sometimes stopped. There have been instances where the motion of the heart has ceased, and also the involuntary action of breathing:—this once happened to myself.

I had the gout in my feet three springs successively, and missed it the fourth. In the fifth spring, one day at ten o'clock in the forenoon, I was attacked suddenly with a pain nearly about the pylorus: it was a pain peculiar to those parts, and became so violent that I tried every position to relieve myself, but could get no ease. I then took a tea-spoonful of tincture of rhubarb, with thirty drops of laudanum, but still found no relief. As I was walking about the room, I cast my eyes on a looking-glass, and

mation, where this subject is further considered. Tiedemann calls the blood-globules "the elementary organic forms;" and several of the French physiologists have thought that they might not improperly be classed with the infusorial animalculæ.]

observed my countenance pale, my lips white, and I had the appearance of a dead man looking at himself. This alarmed me. I could feel no pulse in either arm. The pain still continuing, I began to think it very serious. I found myself at times not breathing; and being afraid of death soon taking place if I did not breathe, I produced a voluntary action of breathing, working my lungs by the power of my will. I continued in this state three quarters of an hour, when the pain lessened, the pulse was felt, and involuntary breathing began to take place. During this state I took madeira, brandy, ginger, and other warm things; but I believe nothing did any good, as the return of health was very gradual. About two o'clock I was able to go about my business.

Here, then, was a suspension of the most material involuntary actions, so much so that the involuntary action of breathing stopped, while sensation and all the voluntary actions were as strong as before.

Quere, What would have been the consequence if I had not breathed? At the time, it struck me that I should have died; but that most probably would not have been the consequence, because, most probably, breathing is only necessary for the blood when it is circulating; but as there was no circulation going on, so no good could have arisen from breathing.*

The stomach appears to have been the seat of this affection. Affections of the stomach appear to have more influence on every part of the body than any other one part has on another; and this sympathy is reciprocal, for every part has a power of affecting the stomach, which shall be more fully treated of hereafter.

Of the second kind of actions, those which may be considered as having the nearest relationship to the first, are digestion, circulation, and respiration; these are all secondary actions of the machine. Those which are not so closely connected with the first, but respect more the actions of other parts of the same body, or what may be called remote parts of the animal economy, are the actions of muscles in moving the limbs, sensations, and voluntary actions employed on external objects, as progressive motion, modes of catching food, &c. We may just observe, that in a muscle itself which has the power of moving other parts, we find the two kinds of actions; first, growth and support as in every other part; and secondly, the action peculiar to the muscle itself. The first kind of actions arise immediately from the living principal, and have

* [It is probable that the circulation, although enfeebled, still continued to be carried on in this case as in Lipothymia, occurring from severe and sudden injuries to vital parts. It would be contrary to every fact with which we are acquainted to suppose that the animal and organic functions could be executed or maintained in an *active* state without a due supply of fresh blood. The respiration is almost if not altogether suspended during the state of hybernation; but then the animal functions, and as far as we know the organic functions also, are suspended. The same thing likewise occurs in those states which have been denominated trances and in cases of Asphyxia.]

always been ranked as involuntary actions; the second are either involuntary, as the actions of whole organs,—the stomach, the heart, &c.,—or are voluntary and dependent on the will, as common muscles, &c.: but these last I shall leave till I have spoken of the brain and nerves.

Besides this action in parts, which I have said is confined to muscles, there is another mode of action introduced, that of parts having the living principle which yet have not a power of self-action like muscles; these are the elastic ligaments.

The elasticity of these parts does not depend on life, for it exists equally in dead as in live parts. Ligaments are employed to assist muscles in keeping certain parts in their places, the position of which is long continued. They may be considered as producing a secondary action in the machine. These are more common in some parts in some animals than in others; such as the neck of quadrupeds, especially those with long necks, as the camel; and on the abdomen of some animals, as the elephant: this power is also introduced in the vascular system.

There are other parts introduced into the machine which possess no action that can affect any other part, but have a kind of passive use in the machine. These vary in their consistence according to the uses made of them, some being extremely firm, as bones, tendons, &c., which sustain the actions of different parts of the animal, and without which it could not subsist; others are less firm, and are employed in uniting the various parts as cellular membrane.

From all that has been advanced, we see that by the juxtaposition or union of living parts organs are formed, which gives us the first mode of action, and the form of bodies gives the secondary mode. By the union of these various parts compound motion is produced. In this manner the whole of the most complicated animal machine is produced. The power of self-action which animal and vegetable matter possesses, distinguishes it from matter endued with any other properties than life, and also distinguishes living from dead matter.*

* [Muscular contractility, which bears not the slightest analogy to any other power of matter, was yet frequently confounded at the time of Hunter with the principle of elasticity. Hunter was the first to show that this was never the source of actual power, like muscles, but depended on a reaction in bodies in a contrary direction to the original impressing force, and always in proportion to it.

It is still, however, very difficult to refer to their true causes many of the phenomena presented by skin, membranes, fibrous coats, &c. which obviously contract and relax in various degrees under different conditions of the system. Most frequently these phenomena are to be accounted for on the principle of *tonicity*, a power analogous to muscular contraction. Some, however, have been disposed to assign elasticity as the sole cause. (See Bostock's *Phy.*, Vol. I. ch. iii. and Majendie's *Lect.* 8—10, *apud Lancet*, Vol. I. 1834—5.)]

CHAPTER V.

FUNCTIONS OF NUTRITION AND ABSORPTION.

The Stomach;—peculiar and essential to animals;—intimately connected with other vital organs;—less with parts not vital;—sympathy with internal parts greater;—compared with the sympathy of the brain with external parts;—greater with ligaments and tendons than with muscles.—Sympathy of the stomach with the mind.

Vascular System;—its actions necessary to be understood.—Arteries:—secretion.—Veins;—formerly supposed absorbents.—Absorbents.—Relative offices of the three systems of vessels.—Various kinds of absorption;—modelling absorption, as during the growth of bones;—absorption of entire parts.—Supposed solvent.—Mouths of absorbents.—Alterations of matter absorbed.—Table of absorption.

Of the Stomach.—EVERY animal body, however compounded, must have the means of support, especially as it is by gradual increase to complete its own magnitude. To this end the living parts fitted for preparing nourishment are thrown into the form of a bag, which is adapted for retaining the food; and this bag is endued with the power of secreting a matter which has the property of converting many vegetable, and all animal, substances into a substance of one kind. This part is called the stomach, and in the less perfect animals it not only makes a considerable part of the whole animal in respect to size, but also in respect to its use in the machine, being the most considerable part of the whole. It may be considered as the first part of an animal, ever becoming more and more simple as the animal becomes more simple; and also as the animal becomes more simple, becoming proportionately the larger part of the animal.

The stomach is the distinguishing part between an animal and a vegetable; for we do not know any vegetable that has a stomach nor any animal without one. It is the converter of the food by hidden powers into part of ourselves, and is what may be called the true animal, no animal being without it; and in many, perhaps in most, it is what constitutes the principal part of an animal. A polypus is little more than stomach. An animal can exist without any senses, brain, or nervous system, without limbs, heart, or circulation, in short, without anything but a stomach. But for the continuance of the species you must have parts of generation; and a polypus is a stomach and parts of generation in one;* and the complicating an animal is no more than adding other parts for

* [“Nothing more is necessary to complete an animal than the power of continuing the species, which power is superadded to this bag in many.”—Hunterian (MS.) Cat. Phys. Series, vol. i. p. 113.]

various purposes.* To one animal which has a brain and nervous system, you have ten thousand without them.

The power and operation of digestion is perhaps as curious a part of the animal economy as any whatever; at present, however, it is not for me to explain these operations, but it is necessary for me to take some notice of the connexion between this viscus and the animal economy in general; in doing which we shall find it to be as much the seat of universal stimulus and irritability as the brain is of sensibility. This connexion, as in the case of sensibility, is much greater in some parts than in others; the connexion that all the vital parts have with the stomach is much greater than between the others, which may be called voluntary, which is only saying in other words that the connexions among the vital parts is more immediate than between the vital parts and those which are not vital.

In diseases the brain seems to be intimately connected with the stomach, and *vice versa*. It was as necessary for the stomach to be connected with the whole body as for the brain, although not in so marked a manner; but that it is as immediately connected with the body as the brain we may certainly say. The affections of the stomach with the body are not so strong as those of the brain, the mind being made sensible of the least injury done to a part, while the stomach is not at all affected under many partial injuries of the body.

The stomach is more affected from the internal economy of the animal than from external influence, which is the reverse of the brain; for external influence in general can only be local, and local injury does not affect the stomach unless it be previously disturbed, or unless the injury is in certain parts, as the brain, the testes, and many of the vital organs, which, as I observed, have a more intimate connexion with the stomach.

The strongest natural affections of the stomach, as respects the body, are those connected with nutrition. These are of the greatest consequence in the machine, and may be said to be of two kinds, namely, want, and the contrary. Want has often been known to produce madness: the contrary may be divided into two kinds,—repletion, and the want of health rendering nourishment unnecessary; and under such circumstances of the machine it is refused to be taken in. Perhaps repletion may be only a negative affection of the stomach with the body; the other is a positive one, and is often

* [Nothing can be more simple than the apparatus for digestion in the lowest animals; but in the higher animals “the parts preparatory and subservient to digestion become more complicated, and indeed so much so, that there is hardly any system in an animal more complicated in itself; and when we consider the varieties of these complications which take place in the various animals, they appear to be almost without end.

“The parts subservient to digestion in the complicated animals bear a great relation to the other properties of the animal,” so that “animals in general might be tolerably well classed by these organs.”—*Ibid.*]

carried so far as to produce a sensation in the stomach, namely, sickness.

The stomach is affected by injuries in parts of the body which have no connexion with nutrition, and more especially with parts which have the least action in the machine. Although it may be difficult to understand why it should happen, yet we find that the stomach is more readily affected by injuries done to tendinous parts, and those which have little sensibility, than by injuries of muscular parts, especially of muscles under the control of the will. This is very remarkable in strains of tendons and ligaments.

The stomach is no less connected with the brain in the internal operations of that viscus concerning external objects or mental operations than in cases of real injury done to that part. A man cannot hear a horrible story or behold distressing circumstances but he will often experience sickness, vomiting, or purging, especially the latter.

The Vascular System.—In many animals, especially the more perfect, the nourishment, or whatever is taken into the system, is taken up and carried from the stomach to the heart, and from thence is thrown out to all parts of the system, through tubes; and from the system it is again returned to the heart by other tubes or vessels. It is absolutely necessary for the surgeon to have a tolerably clear idea of the operations of these vessels. The teaching of the structure and offices of these different vessels more properly belongs to the anatomist than to the surgeon; but as there is one use of the absorbent vessels not generally known, and which is of great importance in many local diseases, and has also an immediate connexion with the original formation of the body, it will be necessary that I should explain this: at present, however, I shall do so but slightly, and trace the action more at large in speaking of local diseases. For the better understanding the whole action of the absorbents, it will not be improper to give a short sketch of the vascular system.

An animal body has in general been considered under the idea of an hydraulic machine, because it appears to be almost wholly composed of tubes in which fluids move. I shall not at present enter into all the different opinions concerning the uses of these tubes, especially of that system called arteries; how they are variously affected, and how they produce their various actions, according to the different stimuli either of health or disease; but shall only give some general ideas of the most important uses of the three different sets of vessels, namely, arteries, veins, and absorbents.

Arteries.—These carry the blood from the general reservoir, the heart, to all the different parts; the veins bring it back again. The arteries constantly dispose of a part of the fluid which they contain in the different operations of the body, according to the different functions of the parts: adding to the whole where growth is necessary; making up losses where the whole is either improper or destroyed; and throwing out of the direct line of motion parts

of that fluid, which, according to the different affections and actions of these arteries, become considerably altered in the process: this is called secretion.

Juices so secreted are intended for various purposes in the machine: some for stimulants, as the bile; some for mechanical purposes, as the tears, synovia, saliva, &c.; some for a store of nourishment, as the fat, &c.; while others are thrown out of the body as useless, because they have already performed all their purposes, as the urine, &c.

Veins.—The other set of vessels, the veins, are considered as less active, being principally employed in bringing back the red part of the blood, after it has lost its most salutary parts, or done those offices, whatever they are, for which it was sent out. This, of carrying back red blood, was not considered as the only office of the veins; many of their beginnings was supposed to arise, not from the terminations of arteries, but from most if not all the surfaces of the body, internal and external; making so many inlets into the general system, and bringing matter into the common mass of fluid for the support of the whole, and also to bring back many of the parts secreted by the arteries from the blood for the different purposes of the machine, such as synovia and lubricating fluids of all kinds; which fluids, having answered their different purposes, and having become unfit for every other use in the machine, were obliged to be brought back again into the circulation, to be thrown out of the circulation by the arteries.

Absorbents.—Such were considered to be the uses of the veins before the discovery of the lacteals; but by the discovery of these they were deprived of part of their supposed offices, namely, that of absorbing the chyle; still they were thought to absorb matter from the cavity of the intestines for the secretion of bile. The other part of the absorbent system, called the lymphatics, though long known, was not in the least suspected of performing the operation of absorption, but was still supposed to be the terminations of the extreme ends of the arteries, not large enough to carry red blood but only serum or lymph, though from their similarity to the lacteals, which were known to be absorbents, it became at last evident to common sense that they must absorb.

Before this idea was started, the general opinion of the vascular system ran thus. The arteries were supposed to carry blood for nourishment, secretion, &c. throughout the machine; the veins to return the red blood, as also to absorb from every surface of the body; the lymphatics to return the lymph or blood which came along the arteries; and the lacteals to absorb part of the chyle from the intestines.

But some experiments which I made to ascertain whether the veins of the mesentery absorbed, proved that they had not the power of absorption.* I do not suppose the veins, even in an erection of

* [See the details of these experiments in Vol. IV.]

the penis, to have the power of absorption; but I consider the corpora cavernosa as veins through which the blood is constantly flowing from the arteries, and that other veins carry off the blood from the corpora cavernosa; that in erection there is a spasm on the extremities of these veins, which prevents the blood from flowing into them, in consequence of which an accumulation and distension takes place, which causes an erection, and this ceases with the spasm on the veins. By tying the veins of a dog's penis, I found I could cause an erection at pleasure, while the arteries continued free.* Now, therefore, the offices of the three systems of vessels were as follow: The arteries remain as before; the veins reconvey the blood to the heart, for a continuance of the actions of the arteries as before, but have lost their supposed power of absorbing; the absorbents alone are employed to take up whatever is to be carried into the circulating system. Now let us consider what are the substances always allowed to be absorbed. 1st, Extraneous matter, in which is included nourishment. 2d, Secreted, superfluous, and extravasated matter, whether natural or diseased. 3d, The fat. 4th, That portion of parts which, being absorbed, causes the waste of parts, as muscles becoming smaller, bones lighter, &c. Although these two last effects were perhaps not expressly said to be carried on by absorption, either by the veins or the other system of vessels, yet we must suppose it was understood.

So far the absorbents have been considered as an active part in the animal economy; but, from a further knowledge of these vessels, we shall find that they are of much more consequence in the body than has been imagined, and that they are often taking down what arteries had formerly built up, thus becoming modellers of the body; and that they are also removing many diseased parts, which were beyond the power of cure.

As these vessels are productive of a vast variety of effects in the animal economy, which are very dissimilar in their intention and effects, they may be viewed in a variety of lights, and admit of a variety of divisions. We shall first consider them under two views. 1st, As absorbing matter which is not part of the machine. 2d, As absorbing the machine itself.

* [In 1830 Mr. Houston announced the discovery of a muscle in the human subject which arises from the ramus of the pubes, and, crossing the dorsum of the penis to unite with its fellow in the mesial line, effectually compresses the dorsal vein whenever this muscle is brought into action. (Dub. Hosp. Rep. Vol. v. p. 459.) A similar muscle, but more perfectly developed, was much earlier discovered by Cuvier in several of the mammalia, to which that eminent anatomist assigned the true use (Anat. Comp. Vol. v. p. 102); in addition to which we may mention that the tongue of the chameleon possesses a highly erectile tissue, and is provided with a similar pair of muscles adapted to fulfil the same object.

Tiedemann, Cuvier, Moreschi, &c., have confirmed the accuracy of Hunter's opinion respecting the structure of these tissues, namely, that they consist of veins enlarged at their origins, and not of a system of cells as has generally been supposed.]

The first is a well known office of the absorbents, and is of two kinds: *a*, the absorption of exterior matter, in which may be ranked everything that is applied to the skin, as also the chyle; *b*, the absorption of interior matter, such as many of the secreted fluids, the fat, the earth of bones, &c. It may be necessary to observe that I do not consider the fat and earth of bones as part of the animal, as they have no action within themselves, and have not the principle of life.*

These actions of absorption are principally employed with a view to the nourishment of the animal, as also to answer many other purposes, as in the absorption of foreign matter, which is extremely extensive and is very important; for besides its salutary effects, it is often the cause of a thousand diseases, especially from poisons; all which is not to our present purpose.

The second office of the absorbents which we are to consider, is that of removing parts of the body itself, which may be of two kinds. The first of these is where only a gradual wasting is produced, either of the whole machine, as in atrophy, or of a part, as in the muscles of a leg or arm, from an injury done to a nerve, tendinous part, or joint: this I call interstitial absorption, because it is the removing a part of the body out of that part which remains, leaving the part still a whole or complete part; a muscle, for instance, that is wasted remains still a perfect muscle. The second is where the absorbents are removing whole parts of the body, and this may be divided into natural and diseased. In the natural, these vessels are to be considered as the modellers of the original construction of the body; and if we were to consider them fully in this view, we should find that no alteration can take place in the original formation of many parts, either in natural growths or in parts arising from disease, without the absorbents being in action to take a considerable part in it. This kind of absorption I shall call modelling absorption. If I was to consider this function in these lights, it would lead me to a vast variety of facts, as extensive as those connected with any principle in the animal economy, for bones cannot be formed without it, nor probably many other parts.

A part which was of use in one stage of life, and becomes entirely useless in another, is removed. This is evident in many animals; the thymus gland is removed, the ductus arteriosus and membrana pupillaris are removed. This process is perhaps more remarkable

* [In regard to the earth of bones, we may observe that its particles are arranged in a determinate and specific manner—constituting an organized body in the most extensive acceptation of that word as distinguished from inorganic matter generally, and from the amorphous ossific depositions which sometimes occur in membranes, muscles, glands, tumours, &c., in which no definite structure is observable. The peculiar stratification and fibrous texture of bone may easily be observed by calcination. This being the case, are we warranted in saying that the earth of bones, forming an organised part of the body, is not alive?]

in the changes of insects than in any other animals. The changes in an insect are very curious. The insect is first a maggot or caterpillar, then goes into the chrysalis state, and comes out a butterfly. Whilst in the chrysalis state it is totally changed, the old parts are almost wholly taken up, and new parts formed; and it is this modelling process that occasions these changes.*

Bones do not grow by having new particles put into the interstices of previously formed parts, so as to remove these to a greater distance from each other, by which means they should grow larger,—as, for instance, if I put a sponge into water, the water getting into all the interstices makes it larger,—but they grow by the addition of new bone on the external surface.†

I took a pig of a very large breed when young, bored two holes in the tibia, and put a shot into each, measuring on a card the distance of each from the other. I allowed this pig to grow up to its full size, then killed it and took out the bone, and I found the two holes at exactly the same distance from one another as at first. Now if the bone had grown in all its parts these two shot would have been removed to a distance from each other proportionate to the growth of the bone.

This fact is also ascertained by feeding animals on madder at different intervals, by which means we shall get strata of red and white bone.

Since we know that bones do not grow by fresh matter being put into all parts, so as to push the old matter to a greater distance, but by new matter laid upon the external surface, let us see whether it is possible for bone to grow and retain its form without being taken down. Let figure 3, Pl. III., represent the head of the thigh-bone of a *fœtus*. Now if the increase was accomplished by superimposed layers, one over the other, as in figure 4, the head of the bone would necessarily become of an enormous size, and in time would come down so as to occupy the middle of the bone, while the cavity in the centre would not be enlarged. Absorption, therefore, must necessarily go on to keep the bone of its proper shape. Hence I call this the modelling process, for without this combined action of absorption and deposition the animal could not grow as it now does.

The absorbents possess the power of removing complete parts of the body, in consequence of disease, an operation which is somewhat similar to the first of this division, or the modelling process,

* [It must be remembered, however, that in insects, where these changes, as Hunter observes, are the most striking, no proper absorbent vessels exist, and indeed the vascular system generally is very imperfect. The changes that take place in the insect transformation have been since ascertained to be rather a development of parts previously existing in a rudimentary state than a total change of parts. In the caterpillar are to be found the rudiments of the future butterfly.]

† [See Vol. IV. for a paper detailing the whole of Mr. Hunter's experiments on this subject.]

but very different in the intention, and therefore in the ultimate effect. This process of removing whole parts in consequence of disease, in some cases produces effects unlike what it produces in others, one of which is a sore or ulcer; in other cases no sore or ulcer is produced, although the whole part is removed. The first I call ulcerative absorption; but for the other I have not been able to find a term.

This process of the removal of a whole solid part of the body, or that power which the animal economy possesses of taking part of itself into the circulation by the absorbent vessels when necessary, is a fact that has not been in the least attended to, nor even been supposed possible; and as I now mean to give a general idea of it, I may just be allowed once more to observe, that the oil or fat of the animal, and the earth of bones, have always been considered as subject to absorption, and some other parts of the body most liable to waste have been supposed to suffer by absorption; but that any solid part should be totally absorbed is a new doctrine. This use of the absorbents I have been able to demonstrate. The first hint I received of it was in the waste of the sockets of the teeth, and also of the fangs of the shedding teeth, which was in the years 1754 and 1755 (see *Treatise on the Teeth*, first and second parts). This opinion was strengthened by what I observed in the process going on in the exfoliation of bones.

It may be difficult to conceive how part of the body should remove itself, but it is just as difficult to conceive how the body can form itself. They are both equally facts. The knowledge of their mode of action would perhaps answer but little purpose.

This, at least, I may assert, that when any solid part of the body undergoes diminution, brought on in consequence of disease, it is the absorbent system that has done it; they are the thieves.

The remote cause of absorption of whole and living parts implies the existence of two conditions, the first of which is a consciousness, in the part to be absorbed, of the unfitness or impossibility of remaining under such circumstances, whatever they be, and therefore they become ready for removal, and submit to it with ease. The second is a consciousness of the absorbents of such a state of the parts. Both these concurring, they have nothing to do but to fall to the work.*

Now the part that is to be absorbed is alive, it must feel its own inefficacy and admit of absorption. The vessels must have the stimulus of imperfection of this part, as if they were sensible that this part were unfit; therefore take it up. There must be a sensation in both parts.

* [The reader, I imagine, will scarcely refrain from smiling at the *naïveté* with which our author here ascribes consciousness and intelligence to an animal body, to an extent little inferior to Boerhaave, Van Helmont, or even Stahl. It were devoutly to be wished that the *body politic* possessed a similar consciousness of what ought to be done, and an equal will and power to carry its resolutions into effect.]

When the part to be absorbed is a dead part, as nourishment and extraneous matter of all kinds, then the whole disposition is in the absorbents.*

This is the only mode in which this power is capable of producing such effects, and, like all other operations of the machine, arises from either stimulus or irritation, all the other modes of destruction being either mechanical or chemical.

[It is by the progressive absorption that matter, or pus, and extraneous bodies of all kinds are brought to the surface of the body. It is by this process that bone exfoliates and sloughs are separated. It is the absorbents which remove whole bones while the arteries are forming new ones. It is this operation that removes the alveolar processes when the teeth drop out of themselves, or are taken out by art; as also the fangs of the shedding teeth, which allow them to drop out; and it is by this means also that ulcers are formed.

It becomes in many cases a substitute for mortification, in which cases it seems to depend upon a degree of strength and vigour superior to that where mortification happens; and in many cases it finishes what mortification had begun, by separating the dead part. From all this, we must see that the causes of the absorption of whole parts are many.

Pressure appears to be one of the greatest causes of absorption, and it is commonly a cause of the progression. It produces its effects not in all cases in proportion to the pressure, but according to the pressure and other circumstances combined; for we find very different effects from the same quantity of pressure: thus, under one circumstance, pressure shall give signs of strength, and produce an increase, or thickening; but under another circumstance the same quantity of pressure shall produce waste, or an absorption of the parts. This difference in effect, from the same quantity of pressure, depends upon the pressure being from without or within, for the first effect of the irritation of pressure from without is the disposition to thicken, which I have asserted is rather an operation of strength; but if it exceeds the irritation of thickening, then the power appears to give way to it, and the absorption of the parts pressed gives way to it.

Pressure produced by an extraneous body surrounded on all sides, such as pus in an abscess, acts equally on every side of the surrounding parts, and therefore, every part being pressed alike, ought, from this cause singly considered, to produce absorption of those surrounding parts equally on all sides, supposing the parts themselves similar in structure, or, which is the same, equally susceptible of being absorbed: but we find that one side only of the surrounding living parts is susceptible of this irritation; therefore one side only is absorbed, and this goes on in regular progression. The side of the cavity which is susceptible of this irritation is always that which is next to the external surface of the body; therefore we have always extraneous substances of every kind determined to the skin, and to that side of the body on which the extraneous substance lies, or to which it is nearest, and that without having any effect upon, or producing the least destruction of, any of the surrounding parts. From this cause we find abscesses whose seat is in or near the centre of a part readily determined to the surface or side in preference to another; and whenever the lead is once taken, absorption goes on there only. But as some parts of the body are more susceptible of this irritation than others, we find that such parts are often absorbed, although they are not in the shortest road to the skin; and of such structure is the cellular

* [It is difficult to conceive how the absorbents can act on detached solid substances, incapable of solution, as bone for example; yet portions of dead bone are often observed to be entirely absorbed in cases of necrosis; and in some experiments made by Mr. Thomas Blizard, in which disks of bone were bound on over ulcers; the surfaces of these disks were found to be eaten out, or destroyed, just as in common caries.]

membrane. We find exfoliations of bones, as well as all other extraneous bodies, approaching the skin in like manner, and from the same cause. But the progressive absorption is always more or less attended with the interstitial, and assisted by it.

The vessels in general would appear to have more powers of perfecting themselves when injured than any other part of the body, for their use is almost immediate and constant, and it is they which perform the operation of restoration on the other parts; therefore they themselves must first be perfect. They would seem to have more of the polypus in them than any other part of the body. This is perhaps more in the absorbents than in the arteries and veins, for we can conceive a part injured by accident, and, as it were, standing still for a little while; but we see ulceration going on very rapidly, which proves an immediate formation of vessels for absorption.*]

The knowledge of the use of the absorbent vessels is of late date, and the knowledge of their different modes of action still later. Physiologists have endeavoured to account for their modes of action on the principle of capillary tubes at their beginning, and this is the most common notion, because it is a familiar one. But this is too confined an idea for an animal machine; nor can it account for every kind of absorption. But as solids are often absorbed, as indurated tumours, coagulated blood, earth of bones, &c., they were driven to the necessity of supposing a solvent. This may or may not be so; it is one of those hypotheses that can neither be proved nor disproved, and must for ever rest as an opinion. My idea is, however, that nature leaves as little as possible to chance alone, and that the whole operation of absorption is performed by one action in the mouths of the absorbents.

But even under the idea of capillary tubes, physiologists were obliged still to have recourse to the actions of these vessels, to carry on the matter absorbed; therefore they might as well have extended the action to the mouths of the vessels.

As we know nothing of the mouths of these vessels, it is impossible we can form any opinion that can be relied on; but as they are capable of absorbing substances in a state of solidity and fluidity, it is reasonable to suppose that they have different modes of action; for although any construction of parts that is capable of absorbing a solid may also be such as is capable of absorbing a fluid, yet I can suppose a construction capable of absorbing a fluid that is not fitted for the absorption of a solid, though this is not likely.

To see the possible correctness of this notion more forcibly, let us only recollect the variety in the mouths of different animals, and

* The preceding paragraphs are transcribed from the Hunterian Catalogue (Phys. Series, vol. ii. p. 5), and are also partly repeated in the work on Inflammation. They are in Mr. Hunter's own words, and serve to complete this subject.

A long and interesting note is added to this part of the Catalogue by the author, asserting the claims of his brother, Dr. William Hunter, to the discovery of the lymphatics, in opposition to the pretensions of M. Noquez. The whole note is very characteristic, and affords an excellent specimen of critical and sound judgment, of a certain combativeness of disposition, and of that homely but vigorous mode of expression for which Hunter was distinguished.

I will venture to say that the mouths of all the different animals have not a greater variety of substances to work upon than the absorbents have; and it may be observed, that with all the variety in the mouths of different animals, this variety is only for the purpose of adapting them to the forms of solids, which admit of great variety, every one being capable of absorbing fluids, which admit of no variety.

I have often said, on this point, that if we could see the mouths of these vessels, we might perhaps class the modes of absorption as animals have been classed, by their teeth, &c.

Matter taken into the constitution by the absorbents is capable of being altered in its nature from what it was out of the constitution. Although this may have been conjectured or imagined, it never has been absolutely known, and even now the only proof we have of it is the change produced in venereal matter. If the matter of chancre or gonorrhœa be absorbed, it produces disease; this disease is not similar to the original; it is not pocky matter which is produced from the ulcers, but this matter has been changed from its original nature in the circulation; although the change was of such a kind as still to retain its power of stimulating and producing disease: but as it was changed, the disease produced was not similar to that from whence it came.

That there is a change in venereal matter is very evident, for if venereal matter out of the constitution be applied to a living part, it always produces an effect according to the nature of the part, which part may be one of two kinds, either, 1st, a secreting surface, producing then gonorrhœa; or, 2d, a non-secreting surface, producing then a chancre.

That this process of altering substances in the constitution is not a universal principle and common effect of all kinds of matter which enter the circulation, is evident; for we do not as yet know, for certain, of any other matter being altered.

TABLE OF ABSORPTION.

Absorption connected with growth.	Absorption for nourishment.	Extraneous matter to become useful, as chyle, fat, &c.		
		Interstitial absorption of parts of the body itself, as cellular membrane, muscles, &c.		
	Absorption of useless, inconvenient, or hurtful parts.	Extraneous, that have been useful, as synovia and other secretions, become useless.		
		Parts of the body itself.	Producing wasting of a part, as a leg, an arm, &c.; or wasting of the whole body.	
			Absorption of the whole parts.	As modellers in the time of growth. In consequence of weakness, as in the removal of calluses. From parts becoming wholly useless, as the alveoli.

Absorption in consequence of disease.	Interstitial absorption.	Partial wasting	{ of a leg or an arm, &c.; or of the whole body, as in atrophy. of a callus of a testicle. of calluses, alveoli, testicles, &c.
		Total wasting	
	Progressive absorption.	As when pus or any extraneous body is brought to the skin.	{ Attended with sup- puration. Without suppuration.
		In the process of exfoliation of bones,	
		In the process of sloughing,	
		In the formation of ulcers,	
Mixed,		In the removal of the fangs of the teeth.	
		As in the progress of pus, tumours, &c. to the skin.	

CHAPTER VI.

OF THE BRAIN AND NERVES.

Passive and active states of the brain;—too much influence attributed to the brain in the bodily actions;—actions of the brain;—five modes of impression on the nerves, or senses. Voluntary action becoming involuntary, as in chorea.—Of sensation. Connexion of the actions of the brain and nerves with life.—Of sleep;—its importance in the animal economy.

WE have hitherto traced animal matter from its change from common matter to animal matter, the particles of which have possessed such an arrangement as to produce life; still it has other modes of arrangement, out of which arise other modes of action, and which only take place in some animals. These are the brain and nerves, which produce sensation, out of which arises mind and reason; for without sensation the mind could not be formed, nor could we reason; it being always about some object that the mind is affected, or that we reason.

In sensation the brain is passive, only receiving the impression from the nerves, according to their actions, called so many sensations. In mind it is active. Mind arises from a peculiar quality in the sensation, being expressive of some quality in the body which is the object of sensation, and which gives an action to the brain answering to those qualities, as agreeable and disagreeable, with all their different species, as love, joy, hatred, anger, &c.; which actions of the brain, or states of the mind, become the causes of particular modes of action in the body affecting both involuntary and voluntary actions. The heart beats quick or slow according to those states; sickness may be produced; purging, contraction of the bladder shall take place; the voluntary muscles hardly obeying the will, but performing involuntary actions, according to the state of the mind.

Reason, by influencing the will, becomes the cause of the volun-

tary actions; and by this connexion all these principles can affect one another.

Now the brain appears to be capable of two modes of action, and out of these arises every property of the brain. We may call the actions of the brain, mind; objects shall affect our senses so as to form a peculiar state of mind: this I call mental impression. Again, the mind can reason and exercise volition respecting objects. The former is involuntary, and belongs also to brutes; the latter is voluntary. For instance, I am challenged to fight a duel, volition, and reason determine me to go to it; but when at the place, my joints tremble, my stomach turns sick: this is the effect of mental impression, or feelings of the mind. The two operations are very different; and in general the feelings of the mind, if strong, will prevent all reasoning.

Much more has been given to the brain and nerves than they deserve.* They have been thought to be the cause of every property in an animal body; that independent of them the whole body was a dead machine, and that it was only put in action by them.

But although their actions are absolutely necessary in the machine, they are not so universally so as has been imagined. They are not the cause of growth, nor do they even preserve a part from death, although the whole as a whole cannot live without them.

The nerves have but one mode of action, namely, that of conveying impressions; but this in two different directions: one from

* [It may here be remarked, that the author, on the whole, lays less stress on the nervous system in his physiology than it probably deserves, at the same time that he gives disproportionate importance to the stomach. Modern experiments have shown that the functions of digestion, nutrition, secretion, circulation, respiration, &c. in the higher animals are intimately dependent on the integrity of the brain and nervous system; and though in some of the lower animals no traces of this system are discoverable, yet may we safely infer, from the irritability which these animals manifest, that something corresponding to a nervous system actually exists, constituting the *materia vitæ diffusa* of the author. Something analogous to this has been suspected in regard to the stomach itself, in certain species of zoophytes, in which either there are no visible stomachs, or else the parts which are generally considered as separate and independent animals are regarded by others as merely a multiplication of stomachs belonging to the same individual. Some experiments also have lately been performed in America which show that undressed animal food undergoes a species of imperfect digestion when inclosed in fresh wounds: from which it seems probable, that notwithstanding the centralization of the vital organs in the higher orders of animals, the separate parts still exhibit traces of those vital endowments which in the lowest order of animals are diffused through the whole body, very much in the same manner as in vegetables. The proper objects of comparison, however, in the present case, are the stomach with the great sympathetic nerve or nerves of the viscera rather than with the cerebral masses. The superaddition of the latter has reference principally to the organs of external relation, very few of which exist in zoophytes and the simpler forms of beings. Physiologically, it is as difficult to conceive of sensibility and contractility without a nervous system, or something analogous to this system, as it is to conceive of nutrition without digestive and circulatory organs.]

their extremities in the body towards the brain, conveying impressions made on them to the brain, in order to excite actions suitable to these impressions; the other, from the brain to the extremities, conveying the mandates of the will, &c.

That mode of action which is from the body towards the brain is of two kinds. One is the internal feel of the body, of perfection, imperfection, power, want, &c. The other is of those feelings of the body which are to call forth the powers of the will to perform what are called voluntary actions, for the subsistence of the body, or to effect the actions which it cannot perform.

The actions of the brain towards the body are also of two kinds: one in consequence of the feelings or state of the mind at the time, whether the actions of fear, courage, anger, love, &c.; the other, in consequence of the command of the will, called voluntary actions.

Those of the body to the brain are the first in order; for it is the receiving the impressions that gives rise to the others. Of the latter, the first are the feelings of the mind, and the second the will and its consequences, namely, voluntary actions, or all those actions, directed principally to external objects, for which muscles are provided.

As the nerves are perfectly passive till impressed by external objects, no one could have any sensation except while an impression is made on some of the senses. Therefore a man should not feel that he exists but in thought; nor could he do that if he had never received impressions to think about, for thinking is no more than the memory of impressions put into order by the mind; nor should he have those actions which naturally arise from the brain till the brain makes the impression on the nerves.

The impression is made on the body, but the sensation is in the brain, for the effect (of a person's feeling in a part to which a nerve is distributed) on cutting or otherwise injuring a nerve, proves that sensation is in the brain, and not in the body; for if it was in the body, the sensation would be referred to the part injured; but sensation being in the brain, and brought from the brain by the action of the nerves, or sensation being formerly in the brain, the action of the nerves we find is referred to the beginnings of that action by the combinations of the other senses; otherwise it would be only in possession of the sensation without any reference. The reference produces a feeling in the mind receiving sensation, by joining it with the seat of impression.

There are five modes of impression of nerves, or perhaps rather five modes of construction of parts, which are adapted to so many kinds of impression. These are called the five senses; but there are a great many kinds of sensation conveyed to the brain or sensorium.

The five senses are no more than parts constructed so as to be capable of receiving impressions, or so many properties of matter. Perhaps all are capable of receiving the impression of touch, or

pressure, if it could be applied to all, so that every nerve may be said to feel.*

But, besides pressure, there are other properties of matter. Many bodies have qualities besides being tangible; some only when in solution making an impression on the tongue and causing taste; the same bodies when thrown into vapour give smell: air, besides being tangible, has a peculiar motion, arising from its repulsive quality, called vibration, which strikes the ear and produces hearing. There arises another property in another species of matter, called light, which we know less of than any other, which has a power of pervading some bodies, called transparent, and gives us the sensation of sight; and from peculiarity in the formation of those transparent parts light becomes more determined in its direction.

The sensation of the glans penis, tickling, and itching would seem to belong to feeling. The first, however, is certainly a different mode of action of the nerve from common feeling, and both itching and tickling require a particular mode of impression to produce them.

An animal can bear with ease a certain quantity of common sensation, which quantity being particularly applied will give pleasure; but if common sensation be increased beyond certain bounds, it gives great pain; so that pain is no more than an increased sensation, such as the sense of violence committed to a part.†

All the five senses are subject to the same mode of sensation when applied in the same way, namely, by touch, and if the impression is too strong, give the sensation of pain. For instance, if the retina be hurt, it gives pain, but not light; if the ear be hurt, it gives pain, but not sound; if the nose be hurt, it gives pain, but not smell.‡ But there are exceptions to the two first, for a blow on

* [It would seem that Mr. Hunter thought that all the nerves of the senses were capable of conveying the sensation of touch or pressure, in addition to the sensation which they are specially fitted to convey. This opinion is not warranted by more recent discoveries. An impression on the retina, of whatever kind, excites the sensation of light. Majendie found that on touching the retina with a couching-needle no pain was excited, but the sensation of light: a blow on the eye has the same effect. If pressure be made with the finger on the sclerotic, a dark spot will be seen immediately at the point of pressure, where the function of the nerve is probably impeded, with a halo of light surrounding it. Of the auditory nerve we know little; and on the tongue and nose the gustatory and olfactory nerves are so intermixed with the fibres of the fifth or nerve of feeling, that it is not easy to distinguish between their actions in such an experiment; but galvanism, which excites a pricking sensation in the skin, causes a peculiar flavour when applied to the tongue; and the smell of the electric fluid is well known.]

† [If this were the case, we should expect to find pain differing only in degree, but not in kind. Some structures, as bone, ligament, and the fibrous structures generally, exhibit no common sensation, although they are actually alive to pain under circumstances of injury and disease.]

‡ [To each of these organs are distributed branches of the fifth nerve, or the

the eye often produces light, and on the ear sound. And besides, those senses are subject to diseases, where the sensation often arises without impression from without.

The common actions of the body, that commonly arise from the will, often become involuntary, as in palsies, St. Vitus's dance, &c.; but I suspect that these actions still arise from the brain or mind, though not the will, because they do not take place in sleep; nor do we find the same diseases in any animal but the human.

Our senses being such, have their peculiar degree of sensation and their peculiar mode of receiving impressions, and when this is carried to too great a length, they become extremely uneasy: but it is an uneasiness different from pain; it is the peculiar sense carried beyond what the mind can bear.

Sensation is in proportion to the impression made on a part, joined with the susceptibility with which the nerve is ready to act. But for distinct sensation two things are necessary, namely, time and space. It is necessary that the impression should be some time in performing, because an impression may be too quick to excite sensation, or quicker than any action in the nerves, such as a ball passing through a man's body without his feeling it; but he is capable of feeling it afterwards, which arises from an action of the injured part, not from the violence itself. Neither must the time be too long, for an impression or an injury may be so slow as not to affect the nerves at all, so as to throw them into any action. A person, for instance, shall become dropsical, and the belly shall fill with water so gradually as to give no pain from the stretching of the muscles, peritoneum, &c.: but if you were to attempt to stretch the belly of another person in a given time to such a degree, it would produce pain in proportion to the violence.

The space must also be determined, for a given quantity of impression may be concentrated so as to be within bounds of sensation; for it would appear that a single nerve or a very few nerves are not capable of conveying sensation, however affected; for instance, a given quantity of light may be concentrated into such a small point as not to be seen.

Every sensation, every mode of sensation, and every sense appear to depend on the quantity of nerves acted upon, and in a given time; therefore we have a great quantity of nerves going to parts that are allotted for strong sensation, that no impression may be made without affecting a great many nerves at the same time.

The uneasiness arising from too strong impressions we can easily assign a reason for, as it becomes a means of avoiding that violence; but itching and tickling appear not to be so very necessary: however they must be of a service in the animal economy. I can conceive itching becomes a cause of our keeping ourselves clean, free from vermin, &c., and becomes a substitute for pain: it na-

nerve of sensation; it is by means of these that common sensation is furnished to the organs of sense, and through them that lesions excite the feeling of pain. See the preceding note.]

turally leads us to the cure, which gives pleasure; and the performance of it is almost similar to the indulgence of our natural appetites.

This principle of sensation is our director with respect to all other external actions, but has no absolute power over the internal economy of the machine. But this first principle we shall find can influence the others very materially, and thus a compound principle will be produced.

The brain and nerves also give the body a consciousness of its own muscular powers. This is more remarkable in other animals than in man: thus, a horse will at once know what he can leap, and will leap no more, nor attempt it; and indeed a man can for the most part tell. A nobleman (the Duke of Queensbury) who had broken his tendo-Achillis was fearful of walking about his room; but I advised him to do it as well as he could, assuring him that his gastrocnemius muscle, knowing its own business better than its master, would refuse to act if he walked, and that the action would be performed by other muscles. This he found to be true. But in the night time, I told him, I could not be answerable for what his muscles would do, therefore I thought proper to put the leg into a fit posture and secure it by a bandage.

As the brain and nerves are composed of animal matter, and as that animal matter has life, or the first principle of action, in common with all the other matter composing the whole body, there arises necessarily an intimate connexion between those principles, and, though totally different in their peculiar actions, yet they become blended with each other, so that one seldom acts perfectly unless the other is in perfect order, each of them calling on the other to do its part; and when both these principles are in vigour and in perfect harmony the whole machine is in health.

Life is coeval with the existence of the animal or vegetable matter itself; but sensation is a later principle, does not take place until birth, when a new economy is set up, in which sensation is called in by the living principle for the support of the whole, beginning first in the stomach by sympathy, and then going on in a series of actions. These compound actions, therefore, cannot take place until sensation takes place; and it is reasonable to suppose that a child in the womb has no sensation, for it is just as well formed in all its parts without brain as with it, and the nerves are indebted to the brain for their formation.*

* [This statement is incorrect. The nerves may exist without the brain or spinal marrow, which are accessory, not the fundamental parts. The same law obtains in regard to the heart and blood-vessels: and indeed it may be observed generally in regard to the progressive development of the higher animals, that at first they follow the type of inferior animals, but afterwards advance to those which are still higher and higher in the zoological scale. Hunter in the main was well acquainted with this law of development as regards the higher animals, as will appear from the following passage, in which we may remark that he has anticipated many of the leading discoveries on this subject by modern anatomists. The passage occurs in the introduction to the description of the drawings relat-

But the moment a new mode of action takes place, actions arising from sensation must be performed for the support of this; and an animal must die if these sensations are not produced, which cannot be produced if there is no brain.*

Actions arising from the union of the two principles, life and sensation, are extremely evident; being all those actions which constitute a state of mind, or those feelings of the mind from which instinct arises.

Sleep.—A singular result of our being possessed of the sensitive principle is sleep. Perfect sleep is an annihilation of the power of present sensation, of the power of thinking, and all traces of the past, or what we call memory. We find that there is, of course, a cessation of all voluntary actions; the will itself is in every respect at perfect rest, and we are at this time, in respect to ourselves, in a state of non-existence. But sleep has its degrees; perhaps in all cases there is a loss of these considerable principles, especially sensation; but the effects of sensation are not always lost, namely, those operations of the mind which produce actions which are very nearly voluntary. During sleep, therefore, the mind may be thinking, which forms what we call dreams; but as our present sensations do not become directors of those actions which the mind is employed about, no such action takes place as the mind forms to itself. It is even possible to dream when awake; it is only necessary for the thinking power to take possession of the mind, and to proceed with an action with which the present sensation has nothing to do, so that a person neither sees objects, hears sounds, nor feels anything that touches him; and when the mind ceases to act and sensation returns, we call it a dream. Now whenever the body loses the consciousness of its own existence, it may be called a waking dream, and this is often the case when people are in deep thought. Sleep appears to be to the sensitive what I have already described to take place in the living principle, when I mentioned my own case; but that arose from disease, while sleep is necessary.

When both these principles undergo a cessation of their actions it is called a swoon. Here there is a cessation of all actions which naturally arise in the body, but still a capability of having them

ing to incubation. "If we were capable" (he says) "of following the progress of increase of the number of the parts of the most perfect animal, as they first formed in succession, from the very first, to its state of full perfection, we should probably be able to compare it to some one of the incomplete animals themselves, of every order of animals in the creation, being at no stage different from some of those inferior orders; or, in other words, if we were to take a series of animals, from the more imperfect to the perfect, we should probably find an imperfect animal, corresponding with some stage of the most perfect." (Hunt. Cat. Phys. Series, vol. ii. p. 4.) Many other passages might be adduced which evince that Mr. Hunter's extensive acquaintance with comparative anatomy had enabled him to deduce the true principles which regulate the formation of the body and the coexistence of the different systems of parts in the same individual organism.]

* [Mr. Hunter must have been aware of many examples of fœtuses without brains which have lived for some time after birth. He must here mean the medulla oblongata, without which respiration cannot take place.]

reproduced, Now in a fainting fit there seems rather a cessation of the actions of sensation, the animal becoming totally insensible to itself; but in a swoon we have this carried further; the cessation takes place not only in the sensitive but in the living principle itself, for we shall have people fall into a trance or swoon, and they shall remain in it without any kind of motion,—respiration, circulation, digestion, and every operation of the body at total rest; and if the disease, or the cause of cessation of that action, should continue a long time, they may lose the power of reproducing this sensation again. Fainting from bleeding, fear, &c., is a swoon in a certain degree, for these principles are diminished, especially the sensitive. Sleep is not only a cessation of voluntary action, but produces cessation of involuntary action of voluntary parts, arising from their diseases, as in St. Vitus's dance, &c.

Sleep is of such material consequence to the sensitive principle of the constitution,—namely, sensation, mind, and will,—that it may be said to constitute one third of its duration. As it is only an annihilation of sensation and all its consequences, one might suppose that it was of little consequence to the machine; but it is as essential to it as food.

Sleep, or rather a cessation of sensation, thus taking place, while the action of life is going on, shows that there must be a peculiar structure, and a principle arising out of that structure superadded, making a compound which is endued with life; for life for a time can go on without sensation, but cannot always go on without it.

Sensation, then, is a fatigue to life; and in proportion to the exertion of sensation, in a given time, the sooner is life wasted. For this reason, when we are in health, sensation stops at proper times; life then appears at ease. This slighter effect of health is often increased preternaturally, as in cases called lethargy.*

* [Dr. Marshall Hall found that the muscular irritability of hybernating animals was greatly increased during their state of torpor. In the same way, sleep, "nature's second best course," seems to be intended to recruit the exhausted irritability of the system after the labours of the day; and accordingly during the condition of sleep the organs both of animal and vegetative life are in a state of repose, the one completely, the other only partially so. Various causes have been assigned for this state, none of which is completely satisfactory.]

CHAPTER VII.

OF SUSCEPTIBILITY OF IMPRESSIONS; OF STIMULI; OF DISPOSITIONS OF THE BODY; OF HABIT AND CUSTOM.

Difference between impressions on animate and inanimate matter; of internal susceptibilities.—Of stimuli;—carried too far they become irritants;—animals susceptible of stimuli at one time and not at another.—Of dispositions of the body;—less well understood than those of the mind;—in health arising from impression;—in disease without it.—Of dispositions in the mind;—their ultimate effects are on the body.—Of dispositions of the body compared with the preceding;—both compared with the actions of machines.—Want of balance betwixt the parts of animals;—parts weakest when at a distance from the sources of power;—why.—Of the memory of impressions;—to be found in the body as well as the mind;—example.—Of the effects of repetition of natural actions.—Definition of habit and custom.—Of custom;—lessened effects from repetition of impression;—increased effects.

EVERY species of matter, whether inanimate or animate, is capable of impressions, and the effects of the impressions, are according to the nature of the impression and the part impressed. All matter is not capable of acting or reacting according to the impression, which passiveness belongs to inanimate matter, though not to all. A piece of dough receives impressions, but seems chiefly passive, not having the power of reacting, and making but little resistance. Elastic bodies receive impressions, which they restore in a contrary direction, producing ultimately various effects, which I have said are the soul or life of mechanism.

In animal bodies the effects of impression are more various and complicated than in inanimate matter, because the most simple animal is more various and complicated in its susceptibilities of impression, and of course more complicated in its dispositions for action.

In inanimate matter there are no actions within itself excepting the disposition to reinstate itself, as in elasticity; therefore impressions are not rising up within itself, in consequence of its own actions, as in animals, so as to produce consequent dispositions and actions, unless we could conceive that chemical and fermentative operations were of this kind. But animal matter having internal actions, these actions are producing impressions which are forming dispositions to action in the parts impressed; and, secondly, it is capable of being acted upon or impressed by common inanimate matter, in both which cases the impressions will be according to the nature of the impressions and part impressed conjoined.

When a man is so affected as to feel within himself that he cannot live, which is very common, it arises from the mind being made acquainted with the state of the body; the living powers are be-

come weak, inactive, &c., and the nerves are communicating the intelligence. Accordingly, their actions are expressive of the extinction of life going on, and the action of brain is expressive of such actions of the nerves; and as death is a something we know takes place, and this sensation of ours is not such as we feel in health, we conclude, from an habitual species of reasoning, that we cannot live, and we are often not deceived. This effect is often so quick that it may exceed the sensation of it, or at least may hardly afford us time to communicate these sensations to others.

The internal susceptibilities, with the consequent impressions and dispositions, are, first, of want, and, second, of repletion; and all the other internal operations of the machine arise naturally from these two, especially repletion, as digestion, circulation, respiration, secretion, the intercourse of the sexes, &c. But the first movement of these actions appears to require the impression of external matter, the powers of digestion being excited by food being thrown into the stomach, in consequence of which circulation, respiration, secretion, &c., all follow, arising out of the internal operations of the machine; all which have nothing to do with the sensitive principle, but are wholly dependent on the living principle. The desire of food, or susceptibility of the stomach to digest it, arises not from external objects, but from its own organization.

The second kind, susceptibility of external impressions, affects principally the sensitive principle, but may also affect the living principle, as in medicines. These are called stimuli; and when both principles are affected they may be said to have the management of the machine.*

Impression or stimulus, produces a disposition to act, or rather action may or may not take place. But all impressions, either on the living or sensitive principle, are not stimuli; some go beyond stimulus, and become irritants;† and other impressions are from their nature not stimulants, but produce a disagreeable impression either to the mind or body, and are also irritants.

Stimuli—An animal, I have observed, is susceptible of impres-

* [It is impossible to avoid remarking here the similarity of this view of Hunter's to Bichat's division into organic and animal actions.]

† [It may safely be said that almost all stimuli, when applied in excess, operate as irritants, and, if carried to their utmost point, as direct sedatives. Thus, electricity, which in a moderate degree irritates the system or rouses it to an unusual degree of action, in a concentrated form immediately extinguishes life. Cold and heat have the same effects, and so have most other stimulants. The same remark applies to those stimuli which in a healthy state proceed from the mind and produce agreeable impressions; as, for instance, joy, which may be exalted to ecstasy, and so occasion sudden death.]

It is probable that the same principle obtains in regard to the internal economy, and that those powerful sympathies which are the result of disease are many of them merely to be regarded as exaltations of natural impressions primarily subsisting between the different parts, which may be carried to any conceivable extent, so as to produce increased action, pain, or an entire destruction of the function. A different class of affections, will, on the other hand, arise from a deficiency in these impressions.]

sions; which impressions, I shall now observe, are to become causes either of immediate or remote disposition to action, either in the part impressed, or some other by sympathy. These impressions, which excite or increase the disposition, are called stimuli; therefore we may say that a part is stimulated, or such an application, substance, or object is a stimulus; and a part either readily increased in action by impression, or brought into action, we say is very susceptible of stimuli. I could wish we had some one word expressive of this condition of the part stimulated, as stimulable, and also of the stimulus, as stimulative, to answer to irritable, sensitive, &c.

An impression which becomes a stimulus by sympathy may have been carried so far as to have been an irritator of the part to which it was applied, as a mote in the eye irritates the tunica conjunctiva, which irritation acts only as a stimulus to the lachrymal gland, for this gland can only act by sympathy. The power of a stimulus must be according to the nature of the stimulus and of the part jointly, for as almost every part of a body has a peculiarity in its mode of action, every part must have its peculiar stimulus.

An animal is so constructed as to have its parts susceptible of stimuli at one time and not at another. An animal has a power of improving its parts so as to make them susceptible of such stimuli as are adapted to the disposition of the parts; for instance, an animal improves all those parts peculiar to the sexes. When those parts are perfect, which is called the age of puberty, they stimulate the mind and various other parts connected with that, giving rise to the passion of love or the appetite of lust.

On the other hand, want becomes the cause of impression: a part becomes susceptible of such want, so that the ultimate effect or stimulus is completely produced, and an appetite arising from such stimulus takes place. Thus, the stomach when empty is susceptible of the stimulus of hunger. This kind of stimulus may be carried so far as to excite a diseased action, and must then be considered as an irritant.

Of Dispositions of the Body.—It may be difficult to define a disposition of the body, but that the body has dispositions is undeniable; and without knowing this, and therefore coming at or endeavouring to come at the knowledge of these dispositions of the body, a man must be a very confined surgeon in his practice. But the term disposition is more commonly applied to the mind than the body. In the mind it is more easily comprehended, because the mind has the power of investigating its own feelings or dispositions, also the power of communicating them, by means of the body, to the minds of others, so as to be understood or felt by those minds.

Every man has felt perhaps every disposition that can arise in the human mind, and is therefore perfectly sensible of those dispositions when they occur in others. But in the present inquiry the mind has no intelligence of the feelings or dispositions of the body,

and is obliged to compare the effects of the one with those of the other, and where they are similar to suppose that the causes are also similar.

A disposition either in the mind or body, when in health, always arises from some impression; but as both mind and body are capable of seemingly spontaneous actions, these may arise from diseased dispositions in both, producing madness in one case and strong disease in the other.

As disposition may arise in consequence of some impression, it is capable of being destroyed by a counter-impression, which in disease is the method of cure that will be called specific. Many dispositions wear themselves out, or are such as the body or part cannot go on with.

A disposition is different from a visible action, yet it is possible it may be itself an action. If we compare the actions of the body with those of the mind (which is comparing from analogy, and perhaps the only mode we have,) we shall gain a pretty good notion of them.

A disposition of the mind, then, certainly arises either from some action of the brain, or a certain position of the parts of the brain takes place, giving them an inclination to action. But this action, or the position which produces the inclination to action, we know nothing of; it is only a sensation of the mind, or rather a consciousness of the mind of such inclination, which sensation or consciousness, is different from the sensation of the brain, arising from other actions of this viscus: and also knowing that such action of the brain as produces such sensation in the mind, is endeavouring to set other parts of the body into action which may be called voluntary, or rather actions in voluntary parts; and that when such actions of the brain have taken place, such dispositions of the brain are lost; I say, knowing so much, we may, knowing from analogy, form some idea of bodily dispositions. But the dispositions of the body appear to differ in this respect from those of the brain, that in the brain there is only the disposition, the ultimate or consequent action taking place in the body. But this is, perhaps, because we are not much acquainted with the immediate effects of the disposition in the brain, being led away by the visible actions which take place in the body.

To explain this, let us suppose that I have an impression made on my body in such a manner that my sensitive principle is sensible of it; if, for instance, a man gives me a knock on the head that makes me angry, I form a disposition from that for resenting it: that disposition in my mind produces an action in my brain which forms a peculiar state of the mind, which is anger. If it was an action of some other kind, it might be affection or gratitude. The brain can do nothing by way of retaliation, whether it be gratitude or revenge which directs, but to set parts of the body to work. Having received a blow on my head, the disposition in my brain to produce the action of revenge sets my hands to work to give my enemy another

blow, and then the disposition is at an end. So that whenever the action has taken place, the disposition is gone.* The ultimate effect is made sensible to us, and we are apt to imagine that it is the immediate act of the disposition of the brain; but it is only that the immediate action which took place in the brain made other parts of the body act secondarily, so that three actions are necessary to the ultimate effect; but they are not all three actions of the brain. There is, 1st, the action which produces the disposition: 2d, the action of the nerves in consequence of the disposition: 3d, the action of the voluntary muscles in consequence of the action in the nerves; but only the two first actions belong to the brain.†

Let us see how far this disposition and consequent action of the brain correspond with the dispositions of the body and the actions arising in consequence of these dispositions.

If on any part of an animal an impression is made, a disposition is formed suitable to that impression, which is the first; and an action in the same part suitable to that disposition may take place, which is the second, and is the ultimate; but if a sympathetic action takes place, it becomes somewhat similar to the ultimate effect on the body, arising from a disposition in the brain.

We may, with great propriety, compare the disposition and action of either the brain or the body with the disposition or action of an elastic body. An elastic body, when acted on, (which is similar to an impression made on the body,) acquires a disposition or inclination, which, if allowed, will produce action in all parts of the elastic body, which destroys the disposition. The disposition to action, and the action, are two very different things in themselves, even in the elastic body: when the elastic body has performed its action, it remains at rest until acted upon again; but it always acquires action to destroy disposition.

We must make a material distinction between a disposition and an action in diseases, for what will cure an action will have no effect on a disposition.

Every machine is composed of very different parts, yet all tend to some ultimate effect. Every machine, whether natural, as an animal body, or constructed by art, however simple it may be, yet is always composed of more parts than one; and it must be observed, that no two parts have the same action, although all are tending even in the most complicated, to produce some one ultimate effect,

* [The disposition does not cease because the action has taken place, but because a new feeling, that of gratified revenge, has arisen in the mind, and taken the place of the previous disposition. Had the blow of retaliation missed its aim, the disposition would have continued, notwithstanding the action had taken place, until a second and more effectual one had been given. This mode of reasoning from metaphysics and false analogy is extremely unsatisfactory, although it must be admitted, that many striking analogies exist between the powers and actions of the mind and those of the body, which Hunter seems to have studied with attention, and of which he has adduced some apt examples.]

† [Or rather to the sensitive principle, which he supposed to be seated in the whole of the nervous system.]

For instance, some machines of art are intended for the division of time, as a clock, which may be so simple as to perform that effect by one wheel, the effect being expressed by an index. Some, again, are much more complicated, all the parts, however, being employed to the same ultimate effect, namely, the movement of this index, which expresses the ultimate effect; and the different parts composing the clock may be called organs.

So it is with natural machines; some animals are so simple as to have apparently but one operation, and that is support, and these may be called one organ. Others are complicated, being composed of different parts, whose actions and effects appear complete in themselves, as the action of a kidney, a liver, &c.; yet all combine to produce an ultimate effect in the machine, namely, the preservation and continuance of the species.

To produce the ultimate effect in any machine, there must be a succession of actions, one naturally arising out of another, each part taking on the action peculiar to itself; the preceding action being always the stimulus to the next succeeding one; and thus the parts go on acting in regular succession until the ultimate effect is produced, and then the whole is at rest until stimulated into action again. In some parts this is almost immediately, as in the heart, organs of respiration, &c.; thus, when the heart has thrown out its blood, it has done its business; when we inspire and expire, the organs of respiration have done their business, but there is a necessity for a recurrence of the operation again, and so immediately that it seems almost constant. But in others there is a greater distance of time before the action is renewed, as in hunger, evacuation of the fæces, urine, &c.

An animal body so constructed, gives us an idea of perfection, for as each part has its particular appointment, one should naturally expect equality or powers suitable to these appointments would be found through the whole. But this certainly is not the case, at least in the more complicated animals, whatever it may be in the more imperfect and simple. We find this in the more perfect, where life depends for support in the action of some one part, as the heart; also where many actions of the animal depend on the powers of another part, as the voluntary actions on the brain; and not only the simple voluntary actions of the body depend on this viscus, but their real strength depends on it, for whenever the power of the brain is taken off, they waste; and this wasting does not arise from the brain supplying these parts with nourishment, and that being now cut off they lose their future support, but it arises from want of necessity to keep these parts in a state fit for action* when action cannot take place, because the will cannot

* [If the exercise of every part is its natural stimulus to perfection, as it certainly is, by exciting the natural actions of which every part is capable, then the want of exercise is the cause of this wasting. The same effect would equally be produced, although the parts should be supposed perfectly capable of executing their proper functions if called upon to do so. The stomach that has long fasted,

now stimulate them to action; and the same thing takes place in a proportionate degree when a joint is simply rendered, either wholly or in part, unfit for motion, where no injury has been done to the nerves. Hence it must appear, that as the power of support is in one part of the machine, and the power of many actions in another part of the machine, it is possible that all parts of the body may not be equally served by the first, namely, the heart; nor equally influenced by the second, namely, the brain; and we do find that the more distant parts from these sources of power are the weakest. This, perhaps, is better illustrated in disease than by any actions of health. We may just observe, that all the vital parts are near the one, and all the acute sensations near the other. In disease we see a mortification arising in the extremities more than in the other parts, and more especially if the person is tall, so that the heart is not capable of propelling the support of life to those distant parts in such a state of the constitution.

How far the blood may lose its power of nourishment before it reaches the extremities, I will not say. If our acute sensations are near to the brain, it is reasonable to suppose that proximity of parts adds to the power of the nerves in communicating sensation; if so, it is reasonable to suppose that proximity of parts will also add to that power which the brain has over the actions of voluntary parts by means of the nerves.

On Habit and Custom.—Memory, or recollection of past impressions, has, I believe, principally been applied to, or supposed to be an attribute of, the mind only; but we know that every part endued with life is susceptible of impressions, and also that they are capable of running into the same action without the immediate impressions being repeated. Habits arise from this principle of repetition of, or becoming accustomed to, any impression, and the same thing exactly takes place in the mind. The memory of the body is of much shorter duration than that of the mind. The mind not only goes more readily into action the second time of an impression, though a considerable distance of time has taken place since it went into the same action before, but seems to take up the action with more ease, from merely collateral causes, from a recollection of the similarity, or often without any possible recollection whatever, as if the actions, in consequence of the former impression, were taking place in the brain again. This does not appear to be so much the case with the memory of the body, for this only arises from immediate impression, but goes into action a second time more readily than at first. Possibly, however, the action arising from the first impression may be repeated from some

or the eye which has long been deprived of light, lose the power of performing their ordinary functions just in the same manner that a joint which has long been confined in one position loses its suppleness and strength, and the muscles waste. This tendency on the part of our author to suppose a sort of intelligential understanding subsisting among the different parts of the body has been already adverted to.]

collateral or similar impression to the first; if so, it comes very near to that of the mind, though not so strong.

A gentleman rubbed in mercurial ointment for the reduction of two buboes; he had only used it a few times when it affected his constitution so much that he was obliged to leave it off: he became feverish, the fever being of the hectic kind, with a small quick pulse, debility, loss of appetite, no sleep, and night sweats. He took the bark, with James's powder. As the effects of the mercury went off, and his buboes were advancing, it was necessary to have recourse to mercury again; he now rubbed in a considerable quantity without its having the least effect on his constitution or mouth; but the buboes spreading, made me order it to be left off again, and they were opened. He had recourse to the ointment the third time without its producing any disagreeable effect. The buboes took on a healing disposition, but then became stationary. I ordered him to leave off the ointment, to go to the sea, and bathe, and then they began again to heal. In about three weeks it was thought necessary to rub in again: when he began, it almost immediately affected his mouth very violently; he left it off till his mouth was a little better, when he began for the fifth time, and it had not so much effect, and he was able to pursue the mercury. Now in this case he had lost the mercurial habit during the time he was at the sea, the parts had forgotten the mercury altogether, and the mercury coming on such a state of constitution, produced the same effect as it would have done if he had not taken mercury. So that the body had, as it were, lost the remembrance of the effect of the mercury on it in so short a time; but the mind would not have lost it.

Custom is with me the negative of habit; by custom comes an insensibility to impression, the impression diminishing although the cause is the same, and the parts becoming more and more at rest; whereas from habit there comes an increased facility to go into action, as also an acquired perfection in the action itself, the impression continuing the same though the cause is diminishing.

These may be reckoned as secondary principles in an animal, and produce two very opposite effects, both according to their modes of impression.

Habit is the continuance of actions we have been accustomed to produce, without any immediate assistance, or even continuance, of the first cause, as a body set in motion continues to move after the cause of motion has ceased to act.

Custom arises from external impressions, either in the mind or body, and is of two kinds, one when, the cause continuing, the impressions and consequently the actions, are diminished, the parts becoming habituated to the impression. We shall see the effect of this in our applications. If we apply a medicine to a sore, which shall affect it in one way or another, (it is immaterial which for the principle, but we will suppose it heals,) from becoming accustomed to that application, it shall lose the impression, and shall at last do

nothing; therefore you will be obliged to make the application more stimulating, more active, or change it for something else. It is exactly so with the mind; if a man goes into a strange place he is affected by the new objects about it; the next time he goes he is less struck; the third time less, till at last, when he goes into the place he can hardly perceive anything strange in it. These very different effects arise from a difference in the degree of impression resulting from the state of the mind or body at the time. In the first instance, if the impression or cause be very slight, so as hardly either to alarm the part or the constitution, they will get familiar with it, and will become insensible to it; a ring on the finger, the use of snuff, our very clothes, and physic itself are striking and daily instances of this. The habit of insensibility will soon be formed if the sensations of the mind and body be not very acute. If the first impression be violent, and such as produces considerable effect, it is not necessary that the same degree of violence should be inflicted to produce a similar effect the second time. One can easily imagine that these impressions may be continued until the parts continue to act without the impression, which would then become habit. If a dose of an emetic be given, which affects the stomach much, the same quantity is not necessary a second time to produce the same effect; the second must be given, however, before the stomach has lost the impression of the first perfectly.*

The same effect is produced on the mind as on the body, for whatever has made but a slight impression, soon wears out, and we think no more upon it. On the other hand, if an animal has met with anything that has affected its mind much, as fear, &c., it is not necessary for the object to appear in the same manner to produce a similar effect.

Those effects will be more or less, according to the state of the body or mind at the time of the first affection; the more irritable or the more ready it is to fall into the first action at the time, the more readily will it take it up the second time, although it may not be particularly irritable or susceptible of this particular action.

Habit.—A habit of acting arises from a repetition of acting, which repetition of acting is custom, and which becomes the cause of the continuance of the same action. So that custom is always prior to habit, or, as it were, forms habit, which may be ranked as one of the secondary principles in the machine.

* [This arises partly from habit and partly from the fact that the emetic has produced an irritable state of the stomach, which renders it more susceptible of the action of any irritant. It would appear that mere impressions, or the passive part of habits (called by Mr. Hunter custom), always diminish in intensity by repetition, but that the actions or thoughts that are put in train by those impressions recur more easily the oftener the impressions are repeated. The reader who is desirous of pursuing this subject is referred to Bishop Butler's admirable treatise on the Analogy of Natural and Revealed Religion, Part I. Chap. V., a book which, like Hunter's Treatise on Inflammation, was the product of upwards of twenty years' labour, and is stamped in every page with characters of the most profound genius.]

The first action being produced by a disposition in, or force upon, the part, this being repeated or continued a sufficient length of time, the action at length goes on, when that original disposition or force is gone, until some other power counteracts it, or it wears itself out. The more we have been in the habit of thinking on any object, the more readily does the train of thinking relating to that object occur. This principal in the animal is similar to the *vis inertiae* in matter, for by it a motion begun is continued, and their remaining at rest is from the same cause. This principle becomes the cause of the actions of the mind; it does not allow men to think differently from what they have been accustomed to think. Men in general go through life with the same modes of thinking, and thus it becomes a cause either of the retardation or improvement of the understanding. It retards improvement, because it gets the better of even present sensations, and does not allow men to wander into novelty. It promotes improvement, because it makes men perfect in what they have been long employed about.

CHAPTER VIII.

OF THE HEAT OF ANIMALS.

The principle of heat a great principle of action in nature;—nature of, unknown;—opposed to cold;—unequal distribution of on the earth;—measures of sensible heat;—absolute heat of bodies, unknown;—of the sensation of heat;—destructive when in a high degree, as is cold.—Natural heat of animals capable of diminution without loss of life;—certain functions first cease;—propagation of the species first;—digestion in some animals, as reptiles.—All animals endowed with heat, but in different degrees;—erroneous notions of its causes; cases in which the function was remarkably deranged;—experiments, showing the power of animals to generate heat in proportion to the necessity;—order of cessation of functions from cold;—diminution of heat during sleep.—Experiments on hedgehogs.—Heat of lower animals varying with temperature of the air.—Standard heat of higher animals not exact.—Experiments to ascertain whether cold acts as a stimulus to the production of heat.—Resistance to external heat;—experiments;—those by Fordyce.—Observations on animals having a standard heat;—differences in the capability of different animals to produce heat.—On differences of climate resulting from temperature;—other causes also act.

THE principle of heat is one of the first principles of action in nature; it is that which unlocks matter, and allows it to act according to its natural properties, or according to its combinations. It may be even said to compel matter to action. But that idea arose, I imagine, more from the effects which extreme heat has both on our sensations, and its immediate effects on our bodies seeming to produce a species of violence, for we do not annex this idea to moderate heat, although moderate and immoderate heat act on the same principle

of putting matter in such a position that certain actions in the matter must take place, all which arises from the nature of the part heated. How far it is an active principle is not easily ascertained, though we must allow it has every appearance of being one.

The term heat meant originally simple sensation, arising from a property of matter capable of producing that sensation, which is only an effect of that property. But philosophers having inquired into the causes and effects of this matter, have, from a poverty of language, applied the word which was at first only expressive of a quality to the thing itself, so that by heat now is also meant the matter of heat abstracted from the sensation which it occasions.* This is so much the case, that Dr. Black† makes use of the term latent heat to signify that heat which a body contains without imparting it to the senses, as we might call the water which goes into the formation of salt latent water: in other words, that water which the salt contains without losing its solidity.

It has been much disputed whether heat is matter, or only a property of matter. If it is simply matter, then, wherever there is heat there must be that matter present. If heat is a property of matter, there must be both matter and property present. If heat is only an action in a particular matter, then there is that matter with its action, as also the body which throws this matter into the action.‡

Heat and cold are opposite principles, and cannot inhabit the same place.§ They occupy different parts of the globe, and in some places alternately; these, therefore, are subject to the variations of temperature, which cause varieties of climate. These will be further spoken of hereafter.

Heat, although not equally distributed all over the globe, yet

* [The sense of this inconvenience has given rise to the general use of the term caloric for the agent which produces the sensation of heat.]

† [In connexion with the name of Dr. Black, we may mention that it was not until this able philosopher had completed his train of researches on the subject of heat that the true theory of respiration began to be understood, or the connexion which subsisted between this function and the production of animal heat. Previous to this time the lungs were considered merely as the agent for cooling the blood.]

‡ [Whether heat consists of a highly attenuated subtle matter which pervades all things, or of a vibration among the atoms of matter, has not yet been decided. Its leading feature is evinced in the repulsion which it produces among the particles of matter, in which respect it is the proper antagonizing force to attraction. Whatever it is, we do not know anything of the principle itself, or of the manner in which it produces its effects.]

The subject of *animal heat* occupied a great deal of Mr. Hunter's attention, in consequence of which he made it the subject of two express papers in the Philosophical Transactions, besides recurring to it again very fully in the Treatises on Inflammation and the Animal Œconomy. The reader is referred to these works in the third and fourth volumes for fuller information.]

§ [Cold was formerly thought by philosophers to be a positive principle, like heat, instead of a mere negation or absence of heat, as it is at present almost, if not quite, universally considered. It is in the former view that Mr. Hunter speaks of it.]

exists in such a degree as to pervade all matter, and is therefore to be found in some proportion everywhere. Heat destroys attractions of all kinds, by which means it becomes the principle of fluidity, and consequently the reverse of the cohesive attraction, or principle of solidity. By means of this effect, motion is allowed to take place among the particles of matter. We have no other idea respecting the variations of heat, except as regards quantity. The quantity of heat has always been estimated by some visible effects, at first probably by our sensations alone, but afterwards by its effects on the expansion of bodies, especially of metals,* all of which is called sensible heat. But it has been discovered lately that many bodies retain more heat than can be made sensible by any of the commonly constructed instruments; therefore a body may have the matter of heat in it without its producing any sensible effects. Hence heat has now been divided by some into sensible and absolute heat. It may be possible that many bodies may have their whole heat made sensible: if so, then their sensible and absolute heat are the same. But it is most probable that the absolute heat of a body can never be known, for the measure of the quantities of heat from every experiment is always by sensible heat, which can never be a proof of the absolute heat in a body.

The real increase of heat must alter the position of parts so as to produce the sensation called heat; and as this heat is diminished, the texture or position of the parts is altered the contrary way, which, when carried to a certain degree, becomes the cause of the sensation of cold. Now these sensations could not take place without a real increase or decrease of heat in the parts. When heat is applied to the skin, it becomes hot in some degree, according to the application. This may be carried so far as actually to burn the living parts. On the contrary, in a cold atmosphere a man's hand shall become so cold as to lose the sensation of cold altogether, and change for that of pain.†

* [It has lately been discovered that minute variations of temperature, utterly inappreciable by the ordinary instruments founded on the principle of expansion, may be rendered evident and estimated by means of electro-magnetical currents, which are found to traverse certain arrangements of the metals when unequally heated. The degree in which the needle deflects from its mean position indicates the quantity of caloric which has entered the heated body, and may be measured by an index of degrees.]

† [It is improbable that the sense of heat and cold depends simply on an "alteration in the [texture or] position of the parts," for if this were the case the same temperature, by inducing the same condition of parts, should always produce the same sensation, although it is well known that this is far from being the case. What to one hand, just removed from a vessel of hot water, feels very cold, shall feel very hot to the other hand just removed from a vessel of cold water; or a part shall feel hot or cold when the reverse of these states is actually present. The sense of change, or the intensity of the impression, is estimated in relation to the previous state rather than to its absolute quantity, or else depends on some peculiar and morbid condition of the sentient organ. Thus, the eye which has long been secluded from light is oppressively affected by the common

Real heat and cold may be carried so far as to alter the texture of parts on which the actions of life depend. Nature has allowed the heat of most animals to come much lower than the heat necessary for performing all their natural functions. This is most so in the more imperfect animals, although it exists in a considerable degree in those possessed of a better regulated standard of heat, as the most perfect.

This answers the wisest purposes, for by allowing the heat to come to that degree in which many actions are suspended, or annihilated, the state of the animal is adapted to the state of the atmosphere, which is such as would render the effects of those actions unnecessary or of no effect.

The first action that is suspended is the propagation of the species; for if birds were to hatch, or animals to bring forth their young, in winter, there would soon be an end to propagation in the temperate and frigid zone, as animals in general only breed once a year.

Cold also annihilates the powers of digestion in all those animals whose food is rendered impossible to be procured in the winter, and which have not power of emigration, such as frogs, lizards, snakes, bats, hedgehogs, &c.

The power of generating heat was the first considered; the possibility of generating cold being hardly suspected, because most people who made observations on this subject lived in an atmosphere colder than their own body. They observed, that in almost all animals there was a standard of heat, which in common language has been called blood heat. However, they extended their observations a little further, and called a certain number of animals the cold-blooded animals, but made no experiments either to ascertain the effects or the principle on which they depended.

If we examine any class of animals, we shall find them, more or less, endowed with this principle, though varying from one another very materially in this respect. The heat of the human body being always considerable, even in the coldest climate, it has necessarily attracted a good deal of the attention of philosophers and physiologists, and various have been the opinions which they have formed respecting its cause.

Friction being a cause of the production of heat in many bodies, was supposed to be the cause of heat in animals, especially, too, as they thought it could be easily explained on this principle, for they observed there was sufficient motion in the body for such an effect, which motion was principally that of the blood. They calculated the size of the internal surfaces of the arteries, which increases as

light of day; and the same thing may be asserted of stimulants and their effects universally.

It is a singular fact that excessive cold should produce effects very similar to those produced by excessive heat. Frozen mercury, for instance, occasions a sensation of burning, and destroys the life of the part which touches it if the contact is prolonged only a few seconds.

they divide. They calculated the size and number of the red globules; all of which furnished an amazing extent of surface for friction; and when they calculated the velocity of the blood moving on this extent of surface, as also of the globules on one another, they thought they saw a sufficient cause for the heat of the body, especially as they saw that when this motion was increased, as in fevers, the heat was to appearance greater. But we may say at the same time, that they did not see the objections to this theory, which are many.

Dr. Stevenson* observed, that there was another cause for the production of heat besides friction, viz. fermentation, and on this principle he accounted for animal heat. But the fermentation of animal substances does not produce heat.

The superstructure built on the foundation that the friction, from the motion of the blood, is the cause of animal heat, falls immediately to the ground on the observation that fluids have no power of generating heat; nor have two solids, if kept asunder by the intervention of a fluid of any kind. If this had not been a fact, still friction probably would not have accounted for all the variety in the production of animal heat. Nor could the principle of fermentation account for all the phenomena which attend the heat of animals; therefore some other principle must be referred to as the cause.

It being discovered that the absolute heat of bodies differs very much in different substances, and perhaps in the same substances differently combined, it was thought that this would account for the production and continuation of animal heat. It is supposed that the air which we inspire has much more absolute heat than the same air has when we expire it, and that the superabundant heat of the inspired air is given to the animal. But this chemical method of accounting for heat will not account for all the varieties in the heat of animals at different times, especially in disease, when the breathing does not equally vary or correspond with the heat of the animal.

A remarkable case fell under my observation of a gentleman who was taken with an apoplectic fit. He lay insensible in bed, covered with the blankets. I found his whole body would become extremely cold in every part, and continue so some time, and in a short time would become extremely hot. While this was going on, several hours alternately, there was no sensible alteration either in the pulse or the breathing.

A man fell from his horse, and pitched on his head, and produced all the symptoms of a violent injury. There was concussion and perhaps extravasation of blood, but no fracture could be seen. The pulse was at first 120°, but came to 100, and sometimes to 90, and

* [Edin. Med. Essays, vol. v. Part II. p. 806, *et seq.* These can only be regarded as specimens of the opinions and modes of reasoning adopted by the mechanical and chemical physiologists of the last and the preceding centuries, to the subversion of which the efforts of Hunter, united with those of Haller, Stahl, and Cullen, mainly contributed.]

was strong, full, and rather hard. He was very hot in the skin, but breathed remarkably slow, only half the common frequency.

His breathing, pulse, and heat therefore did not correspond with this theory of heat.

February, 1781.—A boy about three years old appeared not quite so well as common, being attacked with a kind of shortness of breathing in the night. It had become exceedingly oppressive about five o'clock on Sunday morning, so difficult that he appeared dying for want of breath. In this state he lay till ten o'clock when I saw him. He was breathing so slowly that I thought every breath would be his last, about two and a half inspirations, or even less, in a minute. (The common rate of breathing in such a boy is about thirty inspirations in a minute, and about twenty in a man.) When he drew his breath it was with a jerk; but his expiration was extremely slow, generally continuing through five seconds. I often could not distinguish the pulse, at other times it was very manifest, although very faint and slow, not more than sixty. On tying up the arm the vein did not rise in the least, so that the blood did not go its round. His eyes were turned under the upper eyelid; while his body had a purple cast, especially the lips, which is easily accounted for,—it was owing to the blood not getting the scarlet red in its passage through the lungs, and whatever it might get there was lost in its slow motion through the arteries of the body. He had a fine warmth on the skin all over the body, although in a room without a fire, not covered with more clothes than common in the month of February, with snow falling at noon.

Here it cannot be said that the heat of the body, which was neither great nor deficient, could arise from the constant supply furnished by respiration.

It appears from the account given in the Philosophical Transactions of the experiments made in the heated room, under the direction of Dr. George Fordyce, that Dr. Cullen long ago suggested many arguments to show that life itself had a power of generating heat, independently of any common mechanical or chemical means; though we may observe, that the experiments here related only tend to show the power of producing cold, which they effectually do.

I own I had formed an opinion on this subject. I rather supposed that animal heat was owing to some decomposition going on in the body, and in pretty regular progression, though not the process of fermentation.

In consequence of an experiment made on two carp, to explain another principle in the animal economy, (where every common action was meant to be wholly suppressed, or so far suppressed as to render them incapable of producing heat,) I found an effect produced while the animals were under the experiment which I did not suspect. I began, in consequence, to suspect some other cause of heat than the common or natural actions of an animal; for during the experiment I observed a remarkable reproduction of heat taking

place in these two animals. Until this time I had not an idea that there was a possibility of calling the principle forth, or that cold could excite it.

Experiment. In the year 1766 two carp were put into a glass vessel with common river water, and the vessel was put into a freezing-mixture. The water surrounding the fish froze very rapidly on the inside of the glass all round. When the freezing-process approached the fish it became, as it were, stationary; and the remaining water not freezing fast enough, in order to make it freeze sooner, I put in as much cold snow as made the whole thick. The snow round the carp melted. I put in more snow, which melted also. This was repeated several times, till I grew tired, and I left them covered up to freeze by the joint operation of the mixture and the atmosphere. After having exhausted the whole power of life in the production of heat, they froze; but that life was gone could not be known till we thawed the animals, which was done very gradually. But with their flexibility they did not recover action, so that they were really dead. Till this time I had imagined that it might be possible to prolong life to any period by freezing a person in the frigid zone, as I thought all action and waste would cease until the body was thawed. I thought that if a man would give up the last ten years of his life to this kind of alternate oblivion and action, it might be prolonged to a thousand years: and by getting himself thawed every hundred years, he might learn what had happened during his frozen condition. Like other schemers, I thought I should make my fortune by it; but this experiment undeceived me.*

This experiment laid the basis of many of my future conjectures on animal heat.

I think we may observe in the common occurrences of life that for the actions of an animal a certain quantity of heat is necessary; and this quantity I find to be in some degree according to those actions, the greatest degree of heat being always wanted for the least essential action in every order of animals. However, every order of animals in general requires a heat peculiar to itself, though not always so, some admitting of a much greater variety than others even of the same order, as in the insect tribe.

The actions of an animal may be placed in the following order with respect to its heat, which is the inverse order to that of their immediate use in the machine. Propagation first; digestion; sensation, in which may be included wakefulness; secretion; circulation; each requiring its degree of heat for complete action. Propagation

* [Blumenbach observes that the pupæ of many insects are in winter so thoroughly frozen as to ring like glass or icicles when allowed to drop on the ground, and yet without any injury to the torpid animal within. "The eggs of silkworms and butterflies hatch after exposure to a cold of 24° below zero. On the other hand, insects may be frozen repeatedly, and recovered as soon as thawed." (Elliotson's Physiology, p. 247.) This faculty of enduring cold is infinitely less surprising than that referred to by the last-mentioned author, which allows beetles and other insects to survive being boiled. See note.]

requires the greatest, digestion may be carried on with a degree less, secretion in two degrees less than propagation, and so on.

In the insect tribe there is a difference between a bee and a wasp and many flies. A bee at all times requires a heat above 90 (?) degrees* to support life with ease, while a wasp can allow its heat to vary with the atmosphere without losing life.

When the external heat is so much diminished that it does not assist the natural powers of an animal, and it is obliged to vary its proper standard and become colder, then many of the actions are either lessened or totally suspended, not being necessary: generation is suspended, and insensibility takes place, commonly called sleep; but it is not sleep. Sleep is an effect which takes place in all degrees of heat and cold, though when a man is asleep he is colder than when he is awake, and I find in general the difference is about $1\frac{1}{2}$ degree, sometimes less.† This difference in the degree of heat between sleeping and waking is not the cause of sleep but the effect; for many diseases produce a much greater degree of cold in an animal, without any tendency to sleep. Besides many of the operations of perfect health are going on in the time of natural sleep, at least in the perfect animals, as digestion, secretion, &c., while none of these operations are going on in the tribes called sleepers during their torpid state.‡ In these animals, where a great many actions are suspended, it appears an effect arising from a certain degree of cold acting as a sedative.

Now this degree of cold in some cases seems to act as a stimulant; the animal powers are roused to action for self-preservation. It is probable that most animals are under the influence of cold, and that every order has its degree of cold in which many of their actions can be suspended.

In some countries, where there is summer and winter, there are some animals whose actions are suspended during the winter.

* [Hunter found the thermometer rise to 93° or 98° in a hive of bees in spring; to 104° in summer; to 82° when the air was at 40°, and to 73° in winter. (See his Paper on Bees in Vol. IV.)]

† [There is the same close relation between the ordinary sleep of animals in general and the ordinary sleep of hybernating animals, as there is between this last and absolute torpor. In the 1st, the respiration is diminished and the temperature lessened $1\frac{1}{2}$ °; in the 2d, the respiration is still further diminished, and the temperature reduced to within a few degrees of the external medium; and in the 3d, the respiration is altogether suspended, and the temperature reduced to the surrounding medium. Cold is evidently a predisposing cause to all these states. Cuvier, however, has remarked that in some warm latitudes, as, for example, in the Isle of France; there are certain animals which fall into a state of torpor only during the hot months.]

‡ [There is a good deal of difference in this respect in different animals. The hedgehog and dormouse awake every three or four days when the weather is mild, and during the interval of activity pass the urine and fæces freely, which could not be the case if they did not digest and secrete during their state of torpor. This has never been observed of the bat, because the bat is an insectivorous animal, and would awake in vain if there were no insects. The circulation, however, is continued even in the bat at the rate of twenty-eight strokes in the minute during the state of torpor. (See Phil. Trans., 1832.)]

This suspension of several of their actions seems natural to them, being part of the economy of such animals. In other animals, where a suspension of several of their actions takes place from cold, it seems a force on those actions, as it rather seems to lead to the destruction of the animal than the preservation of life. We cannot give a stronger instance of the forcible power of the suspension of actions in animals from cold than what happened to Dr. Solander and others in their voyage round the world.

Returning from a hill in Terra del Fuego, they were suddenly surprised with a degree of cold beyond what they ever felt before. Dr. Solander advised that they should immediately make their way to the ship as fast as possible, and he himself would bring up the rear. However unnecessary it might appear, Dr. S., who had crossed the mountains in Switzerland, well knew the danger of being left, and told them that they would soon be attacked with an almost irresistible propensity to sleep; that whoever gave way to the feeling would sleep, and whoever slept would die. But after this very serious caution, the doctor was the first who felt the sensation he described, and could scarcely be persuaded by the united efforts of Mr. Banks and the others to proceed. Mr. Banks's black servant, Richmond, was the next whose desire of sleep was very great, so much so that, notwithstanding the consequences, he begged that he might be left to die. The Doctor only begged to sleep a little, and promised that he would then proceed. Mr. Banks, finding the case grow more serious every moment, sent forward four of the company to the first place where they could light a fire, the rest staying and endeavouring to bring up the few who had lain down. The Doctor was awaked, but their efforts were less successful on poor Richmond. In the midst of their endeavours to rouse him, they felt the same symptoms stealing on themselves very fast; it was in vain to attempt carrying, every one being scarcely able to carry himself. Having proceeded about a quarter of a mile, they met two of their party with the welcome news of a fire being kindled at the distance of half a mile. These two were despatched in search of Richmond. Having warmed themselves, and becoming apprehensive for the fate of the two, a party set off in search of them. They had missed their way, and become victims to the malady from which they had endeavoured to restore the black. Richmond was found just crawling, and brought back, but no means had the least effect on the other two.*

* [Many thousands of Napoleon's army are reported to have perished nightly from the same cause during the retreat from Moscow.

Sir B. Brodie classes the effects of cold in the following order:

"1st, It lessens the irritability and impairs the functions of the whole nervous system.

"2d, It impairs the contractile power of the muscles.

"3d, It causes contraction of the capillaries, and thus lessens the superficial circulation and stops the cutaneous secretion.

"4th, It probably destroys the principle of vitality equally in every part, and does not exclusively disturb the functions of any particular organ."

(MS. Notes of Lectures by Sir B. Brodie *apud* Paris.)]

Winter.—I took two hedgehogs, not full grown, from their huts; the weather for some days preceding had been severe and frosty; the heat of the atmosphere was 44° . In one the thermometer was introduced at the pelvis, and the mercury stood at 45° ; and at the diaphragm at 48° . In the other I found the heat in the pelvis 46° , and at the diaphragm 50° .

The degree of heat of these animals being so low, it was compared with the heat of a puppy. The heat of the atmosphere during this experiment being 50° , a thermometer was introduced into the belly and pelvis of the puppy; the mercury stood at 101° , and also at the diaphragm.

Summer.—Atmosphere at 78° . A thermometer was introduced into the belly of a freshly-caught hedgehog. In the pelvis the mercury rose to 95° , at the diaphragm to 97° .

From the foregoing experiments we find that the temperature is allowed to fall lower than the standard, which is productive of no evil excepting suspending such functions as require the standard degree of heat for their actions.

Animal matter endowed with the living principle, whether endowed with action or not, or whether of the first or second order of animals, as far as I am acquainted, admits of the temperature going somewhat lower than would serve for the congelation of the same matter in a dead state.

The more imperfect animals vary their heat according to the atmosphere in some degree.

I made the following experiments on fowls, which I considered to be one degree above the amphibia, and one degree below what are commonly called quadrupeds.

I introduced the ball of the thermometer successively into the rectum of several hens, and found the mercury at 103° , $103\frac{1}{2}^{\circ}$, or 104° . Cocks furnished the same results. In hens during incubation the heat was the same. Living eggs under the same hens raised the thermometer to 99° ; an addled egg only to 97° . So that the living egg had some power of generating heat. In the more perfect animal, as the fowl, the heat is not allowed to come so low as in the more imperfect.

The power of generating heat keeps the higher animals as near one standard as possible; but it was not necessary that this standard should be very exact, therefore we find that they are in some degree influenced by external heat and cold, somewhat similar to inanimate matter and the more imperfect animals.*

As parts recede from the common mass, as extremities, fingers,

* [In the more perfect animals the temperature of the vital parts is more easily elevated above the natural standard than depressed below it. Thus, it was found in Capt. Parry's second voyage, that out of sixteen foxes, which were killed while the thermometer was from 3° to 32° below zero, the temperature of eleven varied from 100° to $106\frac{3}{4}^{\circ}$; and so in other cases it has been observed that the temperature of the blood at the heart bears no relation to the external cold; a fact which cannot equally be affirmed in regard to heat.]

toes, the combs of cocks, &c., they are more subject to be affected by cold, and will raise or sink the thermometer in some measure according to the external degree of heat or cold applied; though not in a proportional degree to this application, as would be the case in inanimate matter.

I put the ball of the thermometer under my tongue, and kept it there for some minutes, when it rose to 97° , but would not go higher. I then took several pieces of ice and put them in the same situation, allowing them to melt. This I continued ten minutes, and found on introducing the thermometer that it fell to 77° , and gradually rose again to 97° .

I thought the urethra would do still better, and I introduced the ball of a thermometer into a man's urethra. At one inch from the extremity the mercury rose to 92° , at two inches to 93° , at four to 94° ; at the bulb of the urethra it rose to 97° . Thus we see that projecting parts are subject to have their heat lowered by surrounding cold.

To render this experiment more conclusive, I endeavoured to render this part colder by applying a colder medium to the penis than the common situation. This part was immersed in water at 65° for a minute. The thermometer, introduced an inch and a half, rose to 79° .

To find if there was any difference in the quickness of heating and cooling between living and dead parts, as also what difference, I made the following experiments.

I procured a dead and a living penis: the heat of the living penis, an inch and a half in, was 92° . I heated the dead one to the same degree, then immersed both in water at 50° . The dead one cooled fastest, but only two or three degrees; the living one coming down to 58° , while the dead one came down to 55° . I repeated the same experiment several times with the same result.

The standard heat of the human body is about 99 , and I believe that degree is pretty regular; however, this regularity in some degree arises from there being in every body a considerable mass of matter which causes less consumption of heat. This standard is necessary for the more material actions of life.

The heat of the more imperfect animals is not the same in every part of the body, even when there appears an equal mass of matter. To ascertain this, I took a healthy dormouse, the atmosphere being at 64° . I put the thermometer into the belly, nearly in the middle between the thorax and the pelvis; it rose to 74° : at the diaphragm it rose to 80° , against the liver to $81\frac{1}{2}^{\circ}$.

As there is some difference between the heat of an animal at the source of the circulation and that of the mouth, pelvis, and rectum, we must make an allowance in judging of the heat of the heart by that of these parts.

I next wanted to ascertain if cold applied to an animal would act as a stimulus, and therefore greater heat be produced than the common standard.

I took a healthy mouse,—atmosphere 64° ,—introduced the ball of the thermometer between the thorax and pelvis. The mercury rose to $74\frac{1}{2}^{\circ}$, at the liver to $81\frac{1}{2}^{\circ}$. I put the mouse into an atmosphere at 30° , and when the ball was again introduced into the belly the mercury rose to 92° , at the liver 93° , the animal being still very lively. Here was an increase of $17\frac{1}{2}^{\circ}$ in the belly, and $11\frac{1}{2}^{\circ}$ at the liver, and this produced by the application of cold to the skin.

Of the Resistance to foreign Heat above the standard.—We have found that animals evidently possess a power within themselves of producing heat when in a cold atmosphere, so as to keep their bodies in a temperature suitable to the economy of the animal. But as animals are often placed in an atmosphere much hotter than their standard heat, I wanted next to see how far they have a cooling power, or, if they have not, to what degree the heat of an animal might be increased, and what might be the consequence of that increase, supposing it possible; for *à priori* we should suppose that the standard heat, or that heat at which all the animal functions are best carried on, would be the medium heat of the animal. But I find from experiment that the standard is generally within a degree or two of the ultimate heat that the animal can bear. As allowing the heat to rise above the standard could answer no wise purpose, Nature has put a check to it by making the stimulus of heat the cause of its own annihilation, just as the stimulus of cold produces, on the other hand, an increase of heat.*

This would appear to take place in two different ways: one is by evaporation, which arises from the action of the living powers; and the other by an immediate power of destroying heat. So that animals have two means of destroying heat, while it would appear that they have only one for the production of it.

I put a viper into an atmosphere at 108° , and allowed it to stay in seven minutes, when the heat in the stomach and anus was $92\frac{1}{2}^{\circ}$, beyond which it could not rise in the above heat.

The same experiment was made on frogs with nearly the same success.†

I now tried to what degree of heat I could bring a more perfect animal; and as I found the penis the best part for trying the experiment with cold, I imagined it would be the best for the trial of heat. The experiments were made in the same manner with the former, only the water was now hotter than the heat of the man. These were only simple experiments, but I chose to make a comparative one with a dead penis.

A living and dead penis were immersed in water gradually made warmer and warmer, from 100° to 118° , and continued in this heat

* [The cause of animal heat is considered in the Treatise on Inflammation, Part II., chap. iii. sect. 3; and the mode by which the temperature is regulated, at sect. 4. The reader is referred to this part of the Work, as well as to the author's paper on this subject in Vol. IV.

† [According to De la Roche, the temperature of frogs does not rise above 80° to 82° in a medium of 110° or 115° . (Journ. de Phys., tom. lxxiii.)]

for some minutes. The dead penis raised the thermometer to 114° , while the living could not raise it higher than $102\frac{1}{2}^{\circ}$. It was observed by the person on whom the experiment was made, that about a minute after the part was put in water the water did not feel hot, but on the water being agitated it felt so hot that he could hardly bear it. On applying the thermometer to the sides of the living glans, while in the water, the mercury fell from 118° to about 104° , while it did not fall above a degree when put close to the dead penis, so that the living glans produced a cold space of water about it.* This experiment may furnish a useful hint about bathing in water, whether colder or warmer than the heat of the body; for if it is intended to be either colder or hotter, as it will soon be of the same temperature with that of the body, the patient, if in a large bath, should move from place to place, and in a warm bath there should be a constant succession of water of the intended heat.†

The experiments made by Dr. G. Fordyce in heated rooms prove, in the clearest manner, that the body has a power of destroying heat.

The action of evaporation produces cold, and in proportion to the quickness of the evaporation is the cold produced; and from experiment we find that the evaporation of spirits of wine produces cold faster than that of water, and of æther faster than spirits of wine. On this principle we suppose that evaporation is one means of producing cold in the living body.‡

It appears from Dr. Fordyce's experiments that the living powers were very much assisted in generating cold by evaporation, but that evaporation was not the sole agent in keeping the body cool. There is therefore a further provision of Nature for enabling animals to support great heat. In order to keep up a just balance of temperature, it is probable that the living powers exert greater effort as evaporation is deficient, and less effort as evaporation increases. In emergencies, evaporation is not sufficient: when a greater power of producing cold than ordinary is required, the powers of the animal are called forth.

As animals can only destroy a certain quantity of heat in a given time, so the time they can continue the full exertion of this de-

* [These experiments on *parts* of the body are evidently inconclusive, inasmuch as any elevation of temperature is necessarily prevented by a continual influx of fresh blood, which carries off the heat.]

† [Upon the same principle the sirocco and scorching winds of the African deserts are so destructive of animal life. In the expedition to discover the N. W. Passage, the sailors found a temperature at zero attended with a breeze far more difficult to resist than a temperature at 50° below zero attended with a calm atmosphere.]

‡ [The influence of evaporation in producing this effect has been fully investigated by De la Roche, who arrived to the general conclusion that evaporation from the lungs and skin is the *main* cause by which the temperature is regulated in all cases, and the *sole* cause by which this effect is produced when the body is exposed to a temperature above its own natural standard. (See Journ. de Phys., tom. lxxiii. lxxi, and lxxvii. See also Treatise on Inflammation, loc. cit.)]

stroying power seems also limited. It is probable that both the power of destroying heat, and the time in which that power can be exerted, may be increased by frequent exercise.

When Dr. Fordyce was in the heated room, his hand became so hot as to make his body feel cool to it.* It is probable that that part, from its habit of changing its degree of heat, is more ready to take on different degrees of heat applied. It is found from experiment, in the application of cold, that all the extremities are more subject to the laws of inanimate matter than the body; and the nearer the source of circulation, the greater the deviation is from these laws. Possibly the same may be observed with regard to heat.

In animals which have a standard heat it would appear to be more natural to form than to destroy heat, (although the power of destroying it appears to be much greater than that of producing it.) for we may observe that they live with much more ease to themselves when in an atmosphere considerably lower than their standard, in which they must constantly be generating heat, than in an atmosphere even of their own temperature, in which it cannot be necessary for them to form heat; so that either this action simply of generating heat, or being in such a degree of cold as makes this action necessary, proves salutary to the constitution.† Perhaps the medium between their extreme heat, which is 98° , and the lowest degree they can come to, is the proper and most wholesome temperature of the atmosphere, and this is about 63° .

Some of these animals which are endowed with this property of a standard heat have this power of generating heat much stronger than others, and are always best in those situations where this power can be exercised: we should naturally suppose that this power always requires a necessity for that exertion equal to its power, so that the power and the necessity should always be proportioned. This cannot be the case with those imperfect animals which have little or no power of forming heat, but are obliged to the atmosphere for heat.

When we consider the white bear, the fox, and wolf, in the more northerly climates, inhabiting countries where the temperature is below zero, yet having a power of preserving their noses, feet, tails, &c., while man, with all his care and art, loses his extremities in the same degree of cold, we must acknowledge that those animals have by much the greater power of generating heat of the two. When we compare the above animals with the lion, tiger, monkey, &c., we find the proportion in the power of generating heat between

* [This effect probably arose from the superior denseness of the cuticular covering of the hand preventing perspiration.]

† [It is certainly a remarkable proof of Hunter's penetrating sagacity that he should have been able to arrive at so general a truth without being acquainted with the true cause of animal heat, or the intimate connexion which subsists between this function and that of respiration. (See Treatise on Inflammation, loc. cit.)]

those two classes of animals still greater; for if the human species finds it impossible to generate heat like the white bear, &c., the lion and tiger must find it impossible to generate heat equal to man: for though they may not lose parts of their bodies when in cold that is tolerable to the human species, they lose their lives in the end.*

It may be desirable to inquire into the proper temperature for each of those classes above mentioned, that is, the temperature in which they carry on their ultimate actions.† This must be ascertained with great difficulty; perhaps the temperature suitable to the white bear, &c. is about 50° ; for the human species about 60° ; for the lion, tiger, &c. about 70° ; and there may be some which require a still higher temperature, though probably none will require a lower than 50° .

On the Effects of Climate.—By climate we mean that state of the atmosphere which is peculiar to any particular part. Climates vary as much as anything in nature. Their difference may be said to arise chiefly from the influence of the sun, from their moisture or dryness, which will depend partly on the shape of our globe and its oblique direction with regard to the sun, and also from the nature

* [Habit in this instance has great influence, so that the calorific function actually increases or strengthens in winter and diminishes in summer, (Edwards, *De l'influence, &c.*, pp. 162 seq., 242 seq.) an effect which we cannot but observe in those who have resided in the East and West Indies returning to an European climate.]

† [By ultimate actions Hunter probably means generation, as he has stated the continuance of the species to be the ultimate end for which the vital powers are given to animals.]

‡ ["Vegetables and animals are prepared for almost all climates, and for temperatures higher than the heat of any country. Dr. Reeve found larvæ in a spring at 208° ; Lord Bute, conservæ and beetles in the boiling springs of Albano that died when plunged into cold water. A species of chara will flower and produce seed in the hot springs of Iceland, which boil an egg in four minutes. One plant, *uredo nivalis*, which is a mere microscopic globule, is said to grow and flower under the snow.

"Some cold-blooded animals bear heat very badly. Dr. Edwards says that frogs die in a few seconds in water at 107° , [but Dr. Marshall Hall states that a frog plunged into water at 120° , "first struggles violently, then experiences convulsive movements, and then promptly dies, whilst the limbs become exceedingly and permanently rigid. After apparant death, all sensibility and motion having ceased, the heart is found to beat for a considerable time, presenting the singular phenomenon of an animal dead to animal life and maintaining a sort of vegetative existence only." (Hall on Circ., p. 174.)—*Editor.*] Yet a species of tænia has been found alive in a boiled carp; but then the carp which it inhabits will live in water as hot as human blood.

"The germs of many insects, &c. are unaffected by a great range of temperature. I know a gentleman who boiled some honeycomb two years old, and after extracting all the sweet matter, threw the remains into a stable, which was soon filled with bees. Body lice have appeared on clothes which had been immersed in boiling water. Spallanzani found long ebullition in the open air favourable to the appearance of the animalcules of vegetable infusions; and the application of great heat in close vessels, although it prevented the appearance of a larger kind of animalcule, did not that of a smaller."—*Elliotson's Phys.*, p. 246. See note, p. 234.]

of the surface, whether hilly, or flat, or woody. The different seasons are dependent on the form of the earth and its motion round the sun. Between the tropics the variations of seasons are less; still there are kinds of seasons, and the climates are very various. The greatest variety of climate is near the tropics. The world there, being chiefly, if not altogether, heated by the sun, works very hard to gain as much of its influence as possible; it exposes itself to it as much as possible in every direction. The air of the equator is very different from that of the poles; few can live in the climate of the poles, either animals or vegetables, and even of those which can live many become torpid during the winter. It is wonderful, considering the necessity of heat to animalization and vegetation, and how partial Nature has been in the distribution of it, how both these processes go on so well as they do.* Nature, however, has been obliged to adapt animals to their different climates as well as vegetables, except the bramble, which lives between the tropics and at the poles.

Some animals become torpid during the cold, others even of the same order do not; this seems to be because the food of the first is not to be found during that season: so Nature formed them either animals of passage, as some birds; others she constituted so as to become torpid. Animals of passage, however, seem to have their peculiar climate; fish, which wander more than most animals, have their climate, and the general cause of their moving south is for the purpose of propagation. So herrings come from the North Pole to the coasts of Europe and America, for no other purpose than to lay their spawn. Quadrupeds seem the best formed for variations of climate, though their heat is more stationary. There are exceptions, as the dormouse, bat, &c.; but men, dogs, deer, horses, &c., live tolerably well, though not without disease, between the tropics and also far north. Nature has furnished some animals with mechanical means for adapting them to climate, as hair, feathers, &c. The use of hair is clearly to preserve warmth: the porcupine of Italy has no hair, but only quills; and the southern bears have only bristles, without hair. There are some animals furnished with proper non-conductors of heat, as seals, sea-cows, &c., whose hair can be of little use to them while living in the sea, and is therefore only useful to them perhaps while on land. Those animals, as whales, which, from living constantly in water, could derive no advantage from hair, have an immense quantity of fat, which is a worse conductor of heat than water by nine to one.†

* [Cold, however, interrupts the growth and nutrition of organized bodies, as may be seen in the short stature and small size of the Greenlanders, Laplanders, Esquimaux, &c., as well as in all the plants and animals of cold and mountainous regions.]

† [The white hair, white skins, and white flowers which characterize the productions of the frigid zone are designed for the same purpose, in as much as heat radiates from white bodies more slowly than from those which are coloured. In

External heat and cold produce diseases peculiar to themselves. Men are the only animals which go to climates not congenial to themselves, and consequently they are alone subject to the consequences of an unfit climate. Too much heat produces diseases of the liver, though, as Dr. Blane observes, this must depend on some other cause than mere heat, as these complaints are not so frequent in the West Indies as in the East.* Diseases of the bowels and tetanus are also often produced by heat; it also tends to produce fevers. The diseases produced by cold are chiefly those of debility, as chilblains, scurvies: also diseases of the lungs, which are more dangerous than those of the liver. Cold also increases some diseases, as the lues venerea: and changes from heat to cold produce some diseases, as scrofula.

As heat is able to volatilize almost all bodies, the impurities of the atmosphere must very much depend on it; but, as Dr. Blane remarks, the same heat which volatilizes bodies will very often decompose them. The plague has not been known between the tropics, nor the jail fever, and very warm climates abound much less with diseases of a putrid kind than temperate climates. How does the atmosphere affect the body? Is it by the lungs or by the skin? This question it is perhaps impossible to solve. The purest air seems, *cæteris paribus*, to be the coldest: and the worst, the warmest, especially when moist, where the situation is low, and where animal substances suspended in it are allowed to putrefy. In a very hot air substances may be volatilized so rapidly that decomposition cannot take place; this air will prove destructive by different modes: 1st, By preventing respiration; for if many substances are volatilized, the air containing them will not reach the lungs, except in too small quantities for the support of animal life.† 2dly, By specific poison, producing a variety of diseases, often sedative, as debility and agues, in marshy grounds; in other places, fluxes and different kinds of poisons. 3dly, The effects of an impure atmosphere are found in jail distempers and hospital diseases; very few of the former places are ever free from foul air, and most hospitals are more or less affected with it. There are different modes in which these poisons may affect. A stranger in a marshy country is much sooner affected

the same manner, all the finer furs and downs come from the high latitudes, whereas cats, rabbits, and other animals change their fur into hair when they are transplanted to a meridional climate.]

* [If, as Tiedemann and Gmelin conjecture, the functions of the liver and lungs are, in one sense, correlative, viz. that they both tend to free the blood of its carbon, then it is not difficult to understand the greater tendency to diseases of the liver in these climates. The blood equally requires purification, and yet this cannot be effected by the lungs without the production of more animal heat than is required; in consequence of which the liver is called upon to fulfill this extra duty, and from over-exertion falls into disease. In the West Indies the sea-breezes materially tend to prevent those consequences which take place in the inland continents of the East.]

† [It is extremely improbable that a case of this kind ever occurred, considered merely in respect of climate.]

than a native or an inhabitant. A person who has not long been used to a jail will earlier, and with more certainty, be affected with jail distemper. An instance of this occurred at Salt Hill in 1760. The effects were at first attributed to the wine; but they were evidently caused by a few paupers, who were examined by some gentlemen, although the paupers did not appear to be affected. In 1775 some prisoners were examined at the Old Bailey who infected the whole Court, and many died; the judge on the bench, the jury and evidences, &c. Many poisons are of this kind: a person may carry the infection about with him without being affected himself.* The air is capable of carrying most poisons, and communicating their irritations. The venereal poison cannot be thus raised in a state of vapour, or if it can, it loses its effects in the change.

Perhaps next to never coming within the influence of such effluvia at all, it is safest to live surrounded by them in large cities, where, either from the habit of being exposed to their action, or from one effluvium destroying another, the effects are prevented from taking place to the extent that might be expected. However, if the atmosphere, being impure, produced an effect only on those coming into it, all the old residents would be equally healthy as the strangers who come to reside for a time only; yet this is not the case, for they are by no means all robust; therefore what may be styled its unfitness produces a debility, and the persons are neither so strong nor so healthy as those resident in a healthy atmosphere, though they feel not the sudden effects with which strangers are attacked.†

We have a kind of atmosphere which spreads over various countries or climates in particular seasons only, as lately over England. These have had different names at different times; we call it the influenza; it affects at first dogs, then horses. In 1775 the dogs were all ill; and afterwards the horses, before men, felt the influence of it.

The atmosphere is the menstruum for various substances, some of which are held in a state of solution, and others in a state of mixture only. Water is held in solution in the atmosphere, and when much of this is suspended, it renders it heavier, as the barometer shows; and when a decomposition of the solution takes place, the water is precipitated as rain or snow, and the air is made lighter, as the barometer also shows. This decomposition may take place, although neither snow nor rain is produced, and this in consequence of a fresh combination taking place before the ultimate

* [The catalogue of infectious diseases is much curtailed in modern times, actually as well as speculatively; at least, the non-contagionists are now the prevailing sect. The infectious miasm probably consists of some compound in which hydrogen is an ingredient. This appears from the facility with which the odour and noxious qualities of putrid exhalations are destroyed by the vapour of chlorine.]

† [The late population returns have exhibited in a striking light the serious effects of crowded houses and a crowded population, in doubling, and in some instances in trebling, the rate of mortality, a fact which is still more strongly exemplified in some of the capital cities of Europe. See Count Chabrol's statistical account of the department of the Seine.]

end is produced. When the above decompositions take place, the birds and beasts seek their shelter; and an effect is produced on wounds, particularly when in a healing state, and in diseases and ailing parts of the human body, so that persons become, as it were, a weather-glass. We have lately been informed by a German that the variations of the magnetic needle have appeared so much to take place with change of weather, that as much might be learned from it respecting the prognostics of the weather as from the barometer itself. Winds may be easily supposed to bring with them the effluvia of disease. Extraordinary effects are produced by the Harmattan wind, a wind which blows off the interior part of Africa to the coast of Guinea. It generally comes three or four times a year, at certain seasons; it is always attended with a fog, which has no taste, nor could anything be discovered in it by means of glasses thinly covered with molasses. The fog is thickest on the beach, and gets tolerably thin about four miles inland. It lasts often for a fortnight, and produces a pain and dryness in the mouth and nostrils, not as if from mere dryness, but from some acridity: if it continues three or four days, the scarf skin falls off, and the tongue applied to that part of the skin denuded of cuticle is sensible of an acrid taste. Though very prejudicial to vegetable life, it is salutary to animals, curing fluxes and other epidemic disorders, and often restoring weakened constitutions. Fevers which had been imprudently reduced by bleeding, got well in spite of the doctor. The small-pox always yields to it, while it prevented the inoculation from taking effect in some African slaves. Such as were inoculated before the Harmattan set in had the small-pox, and all did well; but such as were not then seized with the symptoms, and these were sixty in number, never felt any other affection but a slight fever and nausea during the continuance of the wind; after which it showed itself in twenty of them: the others were reinoculated, and all did well.

CHAPTER IX.

GENERAL PRINCIPLES OF DISEASE.

Disease the consequence of unnatural impression;—may arise from faulty primary arrangement.—Diseased actions often established on the same principles as healthy actions;—some diseases end with the cause;—others continued from habit.—Diseases common to all parts, or peculiar to some;—obscurity of the physiology of disease.—Of susceptibility to impression and consequent action;—difference of susceptibility in different individuals.—Distinction between susceptibility and disposition;—predisposing causes only susceptibilities.—Susceptibilities of constitution and of parts for different actions.—Universal susceptibility producing local diseases.—Susceptibilities almost specific.—Temperament.—Of diseased dispositions.—Dispositions unnatural, but not diseased;—dispositions for restoration;—of necessity;—and of disease.—Diseased dispositions have an allotted time for action.—Action.—Disease a disposition for wrong action;—action the effect of disposition;—symptoms the result of action.—Action, healthy or diseased;—diseased action of two kinds.—First symptoms of disease.—Diseased actions arising without proper stimulus.—Too great action;—too little action.—Diseased actions simple.—Of wrong actions.—Habit of diseased actions.—Of sedatives and stimulants.—Irritability.

Now that I have treated of some of the properties of the animal in health, I shall go on to treat of its imperfections, or diseases. To understand these it was necessary, in the first place, to describe its perfect or healthy state. To describe the parts in a healthy state belongs to the anatomist; their actions in this state to the physiologist; but the diseased state of these actions, and the restoration of parts to health, to the physician and surgeon.

It is hardly to be supposed that disease is ever natural to an animal; it can only be the consequence of some unnatural impression which interferes with the natural action of the body, which impression may take place at the very first formation, or original arrangement of the animal, so as to stamp a permanent unnatural action; or it may take place in the first life, namely, in utero; but much more frequently after birth, when it is exposed to a thousand variations, all which are impressions, and are contrary to the natural actions of the animal, or are, as it were, a forcing it to take on actions which are either to remove those impressions or to destroy itself.

It is most probable that diseased actions are established on nearly the same principles that the actions of health are. They are at least similar in a great many of their principles; they destroy the dispositions of parts; they produce growth; they produce the power of removing natural parts; they are ruled by habit; they are affected by every external influence.

An animal is so constructed as only to continue some diseases so long as the immediate cause lasts, as in scrofula, when it arises from climate; or which is so constructed as to continue other

diseases from habit, as a gleet, so as to go on with a disease, although the first cause is gone; and this may be only for a time, as in gonorrhœa; or it may be for ever, as in lues, cancer, &c.

Diseases are either common to all parts alike, or are peculiar. They are common to all parts alike, as inflammations of all kinds; as, also, tumefaction, scirrhus, dropsies, &c. The peculiar are those in which there is a fault in the peculiar actions of a part, as involuntary action of voluntary muscles, too much or too little secretion from any of the glands, in short, wrong actions of any part in its peculiar mode of action.

After the disposition, the action which should destroy the disposition takes place; the action having taken place, the disposition ceases and the natural action of the parts returns. But this is not always the case. The disposition may be affected in one of the following ways: 1st, The action may destroy the disposition, for instance, in gonorrhœa (and perhaps in many other complaints); in this case the action destroys the disposition, or the inflammation destroys the disposition of the virus. 2dly. The disposition is destroyed for a time, and returns at intervals, or after certain spaces, as in all periodical diseases, or others where the disease ceases for a time, and the disposition continues. 3dly. Where the action takes place, yet does not destroy the disposition, as the venereal disease, which goes on till it is cured or kills, and the action of it never destroys the disposition.*

Many diseases often require their full action before they produce their effects, as the gout and many agues. Vomiting is the action following the disposition to sickness, and is often its cure, for without it the nausea and disposition will continue. Sometimes chronic diseases will be cured by acute ones, in which case, the full action being given, the disposition is removed.

General Observations on Susceptibility and Disposition, constituting Constitutions, and on Actions forming Symptoms.—The physiology of disease is more extensive, more obscure, depends less on general laws of nature (being often a prevention or perversion of those laws), and is therefore more irregular than any part of science, and is of course less understood.

The most simple idea I can form of an animal being capable of disease is, that every animal is endued with a power of action and a susceptibility of impression, which impression forms a disposition;† which disposition may produce action, which action becomes

* [It is scarcely necessary to observe that this dogma respecting the venereal disease is no longer entertained; and indeed it may be questioned whether there is any disease, unattended with actual change of structure, which is not susceptible of a natural cure. This at least seems to be the broad and leading distinction between curable and incurable diseases, although in practice it is often extremely difficult to say what does and what does not constitute change of structure, the simple consequences of inflammation being always excepted.]

† Susceptibility has been too often called disposition. A man is said to be well disposed, or parts are said to be well disposed when they are only susceptible. Disposition is a degree further than susceptibility.

the immediate sign of the disease ; all of which will be according to the nature of the impression and of the part impressed.

That every action, whether natural, preternatural, or diseased, arises from this susceptibility of impression, I think we must allow, which susceptibility may exist without even disposition or action, if no impression or stimulus is made ; for the disposition is only formed in consequence of some impression, and the action is only the consequence of the disposition being so strong as to incline a part for action rather than for resolution. Therefore action is the ultimate consequence of impression being made on a part endued with a susceptibility of impression and the power of action, which impression gives them the disposition to act. For from what was said above, parts having susceptibility do not necessarily have the disposition ; the disposition arises from some impression, which will, in its turn, produce the action, and this action, or disposition to action, must be sufficient to overcome the natural and habitual actions of the part or whole, just as force overcomes the *vis inertiae* of matter. But susceptibilities are in some so strong as almost to approach a propensity to act, which is probably as strong as the disposition, or often probably stronger.*

The actions of the body, and the cause of these actions, with their effects, are exactly similar to those of the mind, and as we are sensible of the actions of the mind themselves, abstracted from their causes or effects, we reason about them as much as we can reason about their causes and effects. This is not the case with the actions of the body, for in them we are only acquainted with the causes and effects, not the action itself ; therefore our minds are only reasoning about them from analogy.

The susceptibility for action of the mind is not known to the mind itself, but by the consequence of such susceptibility. Some minds are much more susceptible of certain actions than others ; thus, some men are more susceptible of anger, others of love. But this does not imply that one mind is always in anger, another in love, &c.

* [The reader will probably agree with the Editor that the distinction which is here drawn is not tenable. The author, for instance, says, (p. 99) that action is not disease, but the effect of disease ; but what proof is there that the disposition (which according to the author seems identical with the disease), exists at all, except from the action which it produces and the visible effects of that action ? And, particularly, what proof is there that this *latent disposition* differs from susceptibility ? A part may be more or less prone to or susceptible of inflammation, but can a part have the disposition to inflammation (in Mr. Hunter's sense), without showing the action of inflammation ? If it can, then where is the proof of its existence, except from the proneness or readiness of the part to act in that particular manner ? which is the idea conveyed by the term susceptibility. I offer this criticism with diffidence ; at the same time I cannot but regard the whole argument, so far as it is founded on this distinction, as based on a metaphysical subtlety which ought not to be admitted in philosophical discourse.

As there can be little doubt that Mr. Hunter formed these opinions from observing that the disposition (so called) to the venereal disease often remained after the visible symptoms had been apparently cured, the reader will naturally turn to this part of his works for further information.]

With this susceptibility of mind, a stimulus must be applied to produce the disposition to action. A stimulus of one kind will produce anger, of another kind, love. The action of the mind employs other parts to complete the whole, as when the actions of the mind are employing other parts to produce the ultimate effects. But these are not necessary to the action of anger, for anger could exist without the action of employing other parts, and indeed continue longer; for this tends to destroy the action of anger, because the effect being produced the cause ceases.

Every animal has a variety of susceptibilities which admit of a variety of impressions, each impression producing a disposition peculiar to itself. Also every animal has some of those susceptibilities stronger than it has others, out of all which a vast variety of diseases is produced. Each tendency to a peculiar mode of action gives the character of the animal respecting disease. The sting of a bee, for instance, affecting some people much more than others, demonstrates that there is a susceptibility in some for such actions more than in others. In many the susceptibility will be so strong as only to require a stop to be put to the natural actions, when the disposition and the disease too will take possession of the part or of the whole. An instance of this we have in scrofula, for it often happens that common accidents, as strains, bruises, fevers of all kinds, produce the disease even in situations the most calculated to prevent it, as in the West Indies. Even poisonous dispositions are produced in this way, a blow on the breast or testicle shall produce a poisonous mode of action, *e. g.* cancer.

From this account no animal is formed with a disposition for the action of disease. The natural actions are for the good of the animal; but they can be perverted, they can be made to destroy the whole. These circumstances are similar to those of the mind; some minds are more susceptible of some impressions than they are of others, which produces a disposition to act, which action will be according to the impression. The susceptibility of the constitution may be increased, so as almost to be similar to a new formation, but is never originally formed, by art.* Where the susceptibility is weak, it may be increased and kept so much on the brink of forming the disposition, that it shall only require the least increase, or some other immediate cause, to produce the effect or form the disposition, as a man not naturally fearful may be worked upon so

* [If by *art* Hunter means the influence of external agents, this statement does not appear to be correct. When, for example, hospital gangrene is prevalent in a ward, probably three-fourths of the inmates would be attacked by this disease, after any operation performed on them. The susceptibility of the disease has surely here been generated, yet they would probably have escaped, if the operation had not come to convert this acquired susceptibility into action. The operation under different circumstances would not have been followed by similar consequences; the body, that is, is not *naturally* susceptible of this disease, in the same way that it is susceptible of inflammation or small-pox, without previous preparation; a new state of the constitution must first be induced,—a point which is clearly admitted by the author in his *Treatise on Inflammation*.]

that the least thing may alarm him. Susceptibilities may be so increased as almost to deserve the name of acquired; constitutions long habituated to particular climates will form a scrofulous habit, or an aguish habit, and a certain way of life will produce a rheumatic or gouty habit. On the other hand, persons naturally susceptible may be made by degrees considerably less so, by being gradually accustomed to the immediate cause, beginning within the degree of impression necessary to excite disposition to action.

There is no such thing, strictly speaking, as a predisposing cause. What is commonly understood by a predisposing cause is an increased susceptibility to form disposition to action. When I say I am predisposed for such and such actions, it is only that I am very susceptible of such and such impressions, which impressions must form the disposition; or if it is intended to dispose a person for such and such actions, it is only to render him more and more susceptible of such and such impressions. The susceptibility must always precede the disposition. A disposition is a determined thing,—a thing formed,—a kind of resolution.

Of Susceptibilities of Parts and Constitutions for different Actions.—Every constitution is more susceptible of some constitutional actions, both natural and diseased, than it is of other actions, whether natural or diseased; and every constitution is more susceptible of some local actions, natural and diseased, than it is of others.

Every constitution is compounded of parts whose natural actions are very different from one another. Thus, the natural actions of the liver are very different from those of the lungs. Therefore we also find the diseased actions of one are often different from those of the other; although every part of the body may be subject to some one or more common diseased actions, as *e. g.*, the liver and lungs, which may be subject to common inflammation, or they may both have the same specific disease, as scrofula.

Every constitution being composed of different parts, whose natural and diseased actions are different from one another, as above mentioned, these actions being according to the nature of each part, and each part in some constitutions being more susceptible of natural actions peculiar to itself than the same part in other constitutions, so also in some constitutions each part is more susceptible of its diseased actions than the same part is in other constitutions. Thus, as the liver in some constitutions is more susceptible of secreting bile, which is its natural action, than it is in others, so also it is more susceptible of its peculiar diseases in some constitutions than it is in others. Constitutions may be said to be more or less susceptible of this or that universal action, among the first of which may be marked the irritable and the indolent.

Secondly, some constitutions are more susceptible of some diseases than others are of other diseases.

Thirdly, some constitutions are more susceptible of some diseases than others are. And those constitutions not susceptible of this or

that disease may be at the same time more susceptible of some other diseases than the first-mentioned constitutions are. For example, some constitutions are more susceptible of inflammatory fevers than of any other fevers; others are more susceptible of putrid fevers; while either one or the other of these constitutions might have some other disease, either violently or mildly, as small-pox, measles, &c.

Constitutions may be more susceptible of some one specific disease than the same constitution of other specific diseases, *e. g.*, some constitutions are more susceptible of small-pox than of measles, or *vice versâ*.

Some constitutions may be more susceptible of some specific diseases than other constitutions are, *e. g.*, some constitutions are more susceptible of the small-pox than others are, and yet have the disease mildly.

All of which characterize the constitution at large.

Of universal Susceptibility to produce local Diseases.—Bodies may be said to be both constitutionally and locally susceptible of diseased action. The erysipelatous fever, which is constitutional, being attended by the erysipelatous inflammation, which is local, is a strong instance of this.

Constitutions are more or less susceptible, both universally and locally, of the same disease, as the small-pox fever, when violent, has more violent and extensive local effects; when mild, more mild local effects.

Constitutions may be said to be more or less universally susceptible of this or that local action, when one part takes on action without any visible immediate cause, or when any injury (whether constitutional, as fever, or local, as accident), makes parts so injured run into a much worse diseased state than the same injury would have done in others; many parts even taking on specific diseases, whenever the immediate cause is produced, as scrofula, venereal gonorrhœa, &c.

Constitutional susceptibilities for diseased actions may be divided into three kinds, and there are also others which are mixed.*

* [There is probably not a more abstruse subject in physiology than that of susceptibilities, which most frequently depend on causes with which we are entirely unacquainted. Mr. Hunter has classified susceptibilities according to their effects and remote causes, without attempting to explain the physiological conditions on which they depend. But we ought not, I conceive, to repose here, as if further progress were impracticable, but to ascertain, if possible, the actual conditions of the organization on which they depend, or the particular manner in which the functions reciprocally react on one another so as to produce them. The pathologist should seek to trace the remote cause to its utmost effects, so as to arrive as near as possible to the immediate efficient cause of the susceptibility in question.]

An example of this kind has been already adduced in regard to the susceptibility of the liver to disease in hot climates, (see note, p. 86,) arising from a reciprocity of function between it and the lungs, of which many similar instances might be given in respect of the other organs. The heart and the brain are said to be more susceptible of disease now than they were formerly, although this

1st, *An original constitutional*; that is, where there is a universal susceptibility for diseased action of one kind or another, in which, however, the whole must be in action, as inflammation, fever, small-pox, &c.; also sympathetic fevers of all kinds. Persons may be very susceptible of the whole of these, or only of one or more.

2d, *Original local*; that is, where the whole is so constructed as to be universally susceptible of going into diseased action in any one part; but the actions will be always local and independent of every other part, as scrofula, gonorrhœa, or chancre. Hence the venereal disease is worse in one than in another, and yet is local; the same with scrofula.

3d, A susceptibility to fall into universal indisposition, as if there was something teasing the whole; which then can call on a part, and that relieves the whole, as in gout, rheumatism, and perhaps all those diseases where the local action is critical. Most of these can be relieved by a universal facility to action, or retarded by the contrary, which will affect either the local action or the constitutional one.

Strong susceptibilities of a constitution to take on diseased disposition and action, whether of the whole as such, or a local effect of a constitutional disease, (which last I call an act of the constitution), only require the impression of the immediate cause for the disposition and action peculiar to these susceptibilities to take place. These immediate causes may not be the same in two constitutions, although both have a strong susceptibility for the same action; for what will produce the action in one constitution may not produce it in another. One constitution will require one immediate cause and another another, though both constitutions may have a susceptibility for the disease. Two men equally susceptible may be exposed to the cause of an ague: one may have the disease the other not. It is exactly similar with the mind: two men may be naturally or constitutionally equally susceptible of anger, but each must have his immediate cause; what will bring forth action in one will have but little effect on the other, and *e contrario*. It is the same thing with every effect of the mind.

Most susceptibilities are so much of a specific nature in themselves that each susceptibility shall be brought into action, in nineteen people out of twenty, in one way, and probably in the twentieth it has been prevented by what produced it in the others. This accounts for the same diseased action in people arising from so many different causes, and also accounts why such disease, though having a specific mode of action, may be varied in the same person

may solely depend on the complicated interests and passions of modern life, which necessarily induce particular physical conditions of these organs which directly tend, on known principles, to the production of disease. The constitutional susceptibilities are, in general, far more obscure, and scarcely at all admit of this mode of explanation.]

in different ways, still more in different people, and even often require different modes of cure.

This theory may be illustrated by every disease that takes on full specific action; whether a full constitutional action, as an ague, or a local one, as the gout. As an ague is a well-known and well-marked disease, this theory will of course be illustrated by this disease.

Every constitution has more or less susceptibility to fall into an aguish habit; but there must be in all an immediate cause to produce the disease. The immediate cause may be such as will make nineteen people out of twenty fall into aguish action; but many constitutions, though they have a susceptibility of falling into an aguish habit, yet when the immediate cause takes place, may have no disposition to take on the full action of that disease; by which means the constitution is teased by what is called a badly-formed ague. If the immediate cause be some local disease in the body, as diseased liver, spleen, &c., then the cure must be effected by the cure of the liver, &c.

This reasoning may be taken in another point of view. Suppose twenty people having different susceptibilities;—introduce something that shall endanger the constitutions of the whole number, and each shall take on the disease that he was at that time most susceptible of, whether ague, gout, or any other.

But often that which would become the immediate cause in those already susceptible of action, or already predisposed to it, by repetition or continuance becomes the predisposing cause in others not susceptible. If two men, one so susceptible as only to want the immediate derangement, the other not at all susceptible of an ague, be sent into the fens of Lincolnshire, the first shall have an ague immediately, because he only required the immediate cause of it; the other, if he does not get the better of the climate by habit, shall become aguish in time, because the country will become both a predisposing and an immediate or exciting cause.

We may substitute for the disease of ague some other disease, and the whole of the above reasoning will be perfectly applicable. But where it is the nature of the disease to take on local action, as in gout, there must not only be a universal disposition for such disease, which is the original, but there must also be a local preference, or rather a local susceptibility superior to the rest; and when the immediate cause takes place, so as to form the disposition, that part takes on the whole action, which relieves the constitution of such disposition, except it should produce another constitutional effect by a vital part taking it up, by which means it would effect the whole constitution similarly to any of the affections of this vital part, where a diseased disposition is formed, but does not take on the regular type of the disease, or does not take on the full and complete action; as in the aguish disposition not having gone through the regular stages of the ague, or gout not having formed a regular fit.

In those diseases that become local, as gout, some attention is to be paid to the seat of action; for if a vital part takes it up, it must be much worse than when there is only a constitutional affection.

The qualities of periodicity and regularity in constitutional diseases, or the power of a constitutional affection to become local, are, I believe, but little understood.

Susceptibilities for dispositions and actions appear to me to be the same with what are usually understood by temperament. Temperament is the state of the body fitting it for the disposition or action it is then in, whether it is only a state of susceptibility, of disposition, or action. The action is always the best test of that state: but, although the action is the best test, yet there are some circumstances attending animals that either dispose them for, or are concomitant upon, such and such susceptibilities; and from these circumstances we can say beforehand, although only in a general way, what are the most predominant susceptibilities for certain actions in this or that animal. We see that even colour in animals depends on a difference in their temperaments, or is concomitant with temperament; for animals with fair skin and hair are more susceptible of cold than the dark, as also of pain. This is well known in the army, where we find that the power of bearing violence committed on the body is in proportion to the darkness of the individual. Fair people are more irritable in their minds, more susceptible of anger, and probably of all other passions. Fair people are also more susceptible of certain diseases than the dark, as of scrofula. This may arise from their not being able to bear the vicissitudes of climate; for it is in changeable climates, especially where there is cold, moisture, &c., that scrofula is more predominant. The irritable inflammation also is more common in the fair than the swarthy. As the fair are less able to resist cold than the dark,* it might be supposed that the dark are less able to resist heat, therefore more ready than the fair to run into diseases which warmth has a tendency to bring on. But from the estimate made by Dr. Young in the Island of St. Vincent's, it would appear that there is some reason to suppose the contrary; from which it would appear that the dark-coloured are rather fitter for all kinds of climates.

Of diseased Disposition.—Dispositions are natural or unnatural, including diseased. The natural belong to the healthy animal, therefore are not to our present purpose.

Dispositions may be unnatural (and of course the actions arising from them unnatural), and yet not diseased.

* [This must be understood with some limitation. The inhabitants of high northern latitudes, who are often very fair, are far less susceptible of scrofula than the darker-complexioned races of more southern countries; as, on the other hand, the African and the half-caste are more liable to this disease when transplanted to a northern latitude than the natives. It is not merely cold, but cold and moisture, associated with a variable climate, which predispose so strongly to this disease.]

Unnatural dispositions and actions we shall divide into three kinds, or they may arise from three causes, which are remote.

1st. The disposition of restoration, in consequence of some injury done, which is also a consequence of every disease which is curable.

2d. The disposition arising from necessity, as the thickening of parts from pressure, ulceration of every kind. This includes a great variety.

3d. Diseased dispositions of all kinds, which also includes a vast variety.

From this division we see that there are two preternatural dispositions that are not diseased, so much so that the first may be reckoned a disposition of health; therefore there is but one preternatural disposition to action, which can be called diseased, namely, the disposition to destruction, and which is to be cured by substituting the first disposition.

Diseased dispositions may arise from some fault in the animal powers themselves, or some extraneous matter in the constitution or circulation, as in the case of many poisons, or from many substances acting on the stomach called poisons, or from some substances being applied externally to the body which disagree with animal life in general, as too much cold, too much heat, &c.

Every diseased disposition most probably has its allotted time for action after the impression, or after the formation of the disposition. This is remarkably the case in specific diseases; but yet this will differ according to the susceptibility. The same with poisons: the small-pox is about six, seven, or eight days at a medium; the measles the same. The venereal disease has a medium, although it varies. But some specific diseases shall remain a considerable time before the action takes place; and this will be much longer in some than in others, according to the nature of the diseased disposition and parts. In cancer it is often very tedious. I have seen instances where it was years after all continuance of the cause was removed before the glands in the armpit had taken on diseased action after contamination.

A girl at St. George's Hospital, fourteen years of age, born in the West Indies, left that part of the world when ten years of age. About a twelvemonth ago she had an eruption on the skin in several parts of the body, especially on the face, arms, and hands. The eruption arose like warts, or like large moles, about the size of half a crown piece, above the surface of the skin, irregular in their base, some standing single, others running into one another, of a browner colour than the common skin, which was clear and of a firmer texture.

Now this was a West Indian disease; therefore I say that the girl was contaminated in the West Indies. The impression was made there which was the first cause, and the disposition was formed; but the disposition did not come into action for three years after. The removal to a cold climate, though it could not remove the disposition or prevent its effects, yet protracted them.

It may be further remarked, in specific diseases and in poisons,

that if the specific disease or poison is such as is capable of contaminating different parts, whose powers or readiness to act is different, the same disease will show itself at different intervals in these places in the same person, though perhaps every part is contaminated at the same time. Thus we have the venereal disease appearing in different parts at different intervals in the same person, arising from the natural susceptibility for action in some parts being greater than in others. The skin and tonsils being most susceptible of contamination, as also of action, are therefore affected soonest; the bones and tendons less so, and are therefore later in taking on the action. The disposition simply does not seem to affect either the constitution or the part, (see note, p. 91) for either shall go on well with all their natural functions, and powers of restoration when injured or affected with diseases of every other kind, although at the same time in the disposition of some other disease.

Dispositions of one kind may be restored after being destroyed for a time by a more powerful impression, or such as the constitution is more susceptible of, which shall supersede the first disposition, and go on with its actions; and when its action is completed, the first disposition shall again take place, as will be illustrated when we come to talk of actions simply.

Action.—I have explained that a disease is a disposition for a wrong action, and that the action is the immediate effect of the disposition, and that either the actions, or the effects of those actions, produce the symptoms which are generally called the disease, such as sensations, which are commonly pain of all kinds, sickness, alteration visible or invisible in the structure of the part or parts that act, and sympathy.

The animal, or part disposed to act, generally takes on action, which is of three kinds: natural, restorative when injured, and the diseased; each arising from the corresponding class of dispositions, and therefore divisible into the same.

The actions of health arise from a disposition to act properly, that is, according to the combined laws of the machine, which may be either universal or only partial; for a man may be wholly in health, or only so in part. The actions of restoration are for the falling back into the above natural actions, and which will be according to the nature of the injury done and the parts combined. The diseased actions are many, but may be ranked under the following heads:

1st. Improper actions of natural parts, as spasms of muscles; irregularity in the times of action of a compound part. The nerves have the credit for being the remote cause of all these.

2d. Unnatural or improper actions of the vessels; and these may be either attended with an increased or diminished action.

The ultimate and visible effect of disease is action; but this is not the disease, for the action is only an effect, a sign, or symptom of disease. But the disposition being only discovered by its effects, we are apt to go no further in our inquiry, the cause being to many

only an object of curiosity. However, the effect must be attended to, for it is this which leads us to the cause. These actions may arise from poisons, or substances improperly applied to the surface; from cold; from substances taken into the stomach: these usually give a sensation to the animal, so that it can judge that the parts are diseased. But sometimes the action is too slow to give an alarm to the part; or the disease is felt through the irritation; or by a part remote from the diseased part sympathizing, as worms in the intestines, producing convulsions, an itching at the nose, &c. When the hip or loins are affected, the sympathizing part, before the disease is felt in the original seat, is the knee. Passing a bougie has caused sickness before it was felt in the urethra, as has a clyster before the rectum was sensible of any inconvenience.

Often the internal feeling of health is the forerunner of disease. People just before a disease shall be in better spirits, and feel strong, so as to take notice of it themselves.

A gentleman had better health before a spitting of blood came on.

A boy had more spirits than usual the night before he was attacked with the cold fit of fever.

Perhaps the cause of disease gives the first feeling of health or vigor: the animal powers are called up on the first alarm of disease; and when they sink, which is the second stage, they produce cold, or shivering, which is generally supposed to be the first symptom. In children I have often observed that the smell is affected before diseases. The first impression here is made on the olfactory nerves.

Some diseases come on extremely rapidly, producing at first very violent symptoms, called acute: others come on very slowly, and do not produce any sensible first symptom.

I have already observed, that all the actions in a healthy state are only produced by their proper stimulus; but sometimes we have actions without proper stimulus, which are diseased actions. In all organs I have observed there is a regular succession of action, as in the secretion of different substances, according to the wants of the parts which become the stimuli; but they may perform this office without the stimulus. The vessels are very active parts, and have often wrong actions, producing diseases in a great variety of parts, and are peculiarly active in the operations of disease.

Too great action will produce disease, according to circumstances. As the powers are equal, or greater, the action is universal or local: if universal, as in inflammatory fever, it will either produce resolution or death; if local, as in inflammation, either resolution or suppuration; or if the action is greater than the power, irritability; or it may keep up a constant inflammation; or if very violent, produce mortification. Too great action will often in the end produce too little action; but not often *vice versa*. General action or fever may produce local, as inflammation; or local inflammation will produce general, as fever. They often attend one another from accident, and then they generally increase one another.

Too little action arises from a disposition to act within the neces-

sary bounds of health, which produces real weakness and a bad state of health, with debility, without any visible state of disease, as we often see in fine ladies. If the part debilitated be not necessary to life, it only produces its effects on that organ. Too little action may subject the person to many more diseases than what the active are subject to. Even the habit of indolence in the mind, joined with inactivity of the voluntary actions (which is generally produced from an indolent state of the mind), produces the same effects, especially as we see in women. So that weakness is attendant on many diseases, and although somewhat necessary to many, yet it is not actually the disease itself. For instance, weakness attends the scurvy, and is necessary before the full effects of the specific disposition, namely, the action, can take place. The same in locked jaw, scrofula, &c. Weakness becomes one of the causes of irritability, as will be explained. Weakness, too, produces an increase of the disease. It may be local or universal, for many parts of an animal body may be weak, while others are strong; and if the weak parts are not essential to life, then the effect is only debility in performing the function, and the vital parts may not suffer. If the nerves are weak, the voluntary parts suffer; if the stomach, then the whole will suffer, or there may be a weakness which includes the whole without destroying it. It sometimes seems that the suspension of action for a time, increases the power afterwards; and lessening the power of action, increases the real strength at other times.

All diseased Actions are simple.—A disposition of one kind may and shall exist in a part or whole, while an action of another kind is going on; and when the action ceases, the disposition, or dormant action, if we may be allowed to call it so, shall then come into action.

There are certain natural actions arising in an animal body in consequence of every irritation, whether appearing as a spontaneous injury or from accident. These common actions I shall illustrate by inflammation.

Inflammation, then, is one of these simple actions; but we find inflammation may be joined with a specific quality which shall not alter its apparent mode of action, yet shall cause its ultimate effect to vary; thus, though the mode of action is altered, the action itself is not altered.

It appears to me that every disposition must be simple, and therefore be only capable of producing simple action. Parts so disposed may be irritated by something that alters the disposition. If the old disposition be destroyed, a new one must be produced: but if the disposition be only altered in part, there may be the two dispositions in the same part, the old in part and the new in part. But it is possible that a new disposition may be formed out of the two, different from either of the two which formed it; still it must be considered as a simple disposition.

This is plain in the cure of the venereal disease; a third disposition (namely, the healthy,) arises out of the two, that of the disease

and that of the remedy. This is likewise shown in the action of Dover's Powder, for neither vomiting or sleep is produced, but a third action, namely sweating.

But a constitution or part may have equally a susceptibility to a variety of diseases, as venereal, scrofula, &c., some of which may have a common cause, others a specific, as lues; yet the constitution can have at the same time only one specific action. As there are susceptibilities for dispositions, so there must be also dispositions for actions; yet two of these cannot exist at the same time in the same part or constitution.

Two children were inoculated for the small-pox. Their arms inflamed; but about the third or fourth day from the inoculation symptoms of fever arose, and the measles appeared, and went through their progress as usual. During this time the inflammation in the arm was arrested; but when the measles were completely gone, the small-pox took place, and went through its progress.

Here a disposition for the measles had taken hold of the body, but although it had done that previously to the small-pox, yet it was not in such a way, as stopped the progress of the small-pox. The small-pox matter was capable of contaminating, and produced inflammation, which went to a certain length, but the moment the measles changed their disposition into action, as the two actions could not go on together, the action of the small-pox was suspended till the measles had gone through its action, and the moment the constitution got free of this, the small-pox began to act again.

A lady of rank was inoculated by Mr. Sutton. A few days after a fever came on, of the languid or putrid kind, but without any eruption, except a few petechiæ on the breast: she went through the process of a low fever, and afterwards the small-pox commenced; yet when the pustules matured they spread wide and were very large: also a different set of eruptions succeeded, so that thirty days passed before the skin was clear of the eruptions.

These cases show that but one mode of action can take place at the same time; yet I could conceive that two actions might produce a third one, which might have been a new poison, as the last case in some measure seems to show.

Of wrong Actions.—I have already mentioned, under the animal economy, the two different kinds of action in an animal: 1st, The natural powers of growth, modelling, &c.; 2d, The powers peculiar to each part, voluntary or involuntary. Now, the first may act improperly: it may push forth unnatural and unnecessary growth in some parts, and too little in other parts. They may also act in such manner as to obstruct the necessary actions of the machine, as by unnecessary masses called tumours, increase of the bones, &c. The second may also act wrong, that is, may act without the necessity for action, as in spasms, locked jaw, over-secretions, palpitation of the heart, &c. This is in every respect similar to the former, only the improper action is on a different part. If, then,

improper actions fall on a part of importance to the machine, they produce disease: or they may act too little, and thus produce diseases of a different kind.

Diseased actions, like the actions of health, become accustomed to impressions, and we see many of them subject to the same laws. This is of two kinds: first, where the diseased part becomes less and less affected by stimulus, from a continuance of the application; second, where the whole body, or a part, becomes more easily affected by the stimulus, from a repetition of the application.

People constantly exposed to the cause of certain diseases become less affected, or less liable to be affected. Perhaps the best way to prevent being affected by some infectious diseases would be to live constantly where the infection was. People coming out of the country into the town are more liable to be affected by certain infections, as the small-pox, than those who live constantly in large towns. The constitution having once felt the stimulus of the small-pox, is not afterwards affected by it; yet I can readily conceive that if a man were to live two hundred years he might arrive at that period when he would again be susceptible of the impression.

Of Sedatives and Stimulants.—Perhaps there is no idea of any principle, simply as an idea, more correct than that conveyed by the word sedative, stimulus, irritation; yet I think it is probable that there is no idea so little understood in practice; and it may be a very difficult task, and next to an impossibility, to say what real state the body or part is in, or can be brought into, to be affected in either one or the other way. This arises from our imperfect knowledge of the true state of the body or parts, or of their economy; for what might act as a sedative at one time, might be a stimulant at another, or even an irritant; or what might be a sedative to one part, might be either a stimulant or irritant to another, which we shall see to be really the case, for whatever will excite action, even the common action of parts, will be a stimulus, and whatever will excite actions beyond the real strength of the body will be an irritant; and this cause of excitement beyond the common action may be no more than what at another time would act as a sedative.

For example, without heat, probably no action could take place either in common vegetable or animal matter. Heat admits of becoming an exciter to action; but as heat, in so far as it can, only excites natural actions, and, in due proportion to the strength of the parts, it may be called sedative; for we may suppose that by sedative is not meant an unnatural reduction of action (for which, indeed, we have no expression), but the production of a natural action from too great an action. It may increase or diminish action, according to circumstances. But to ascertain the precise degree of heat suitable to every state of body or part, so as neither to increase nor diminish action, is probably impossible.

When animals are extremely weak, their actions should be suitable to their strength. Or if an animal is only moderately weak

in the whole, considered as a whole, yet there will be parts that will be very weak; and if those parts are under disease, care should be taken that those parts are not thrown into action above their strength.

The temperature of the body, or parts respecting heat and cold, should be in proportion to this weakness, which will regulate the action, and to apply warmth at such time would be applying a stimulus; and if the body was still more reduced, warmth might become an irritant; or if the body was not able to act up to this stimulus, it would be an irritant.

To lower actions suitably to the state of the constitution, whatever this may be, is the use of a sedative; but in some constitutions it may be requisite to bring it even lower. So it is often necessary to produce fainting; but this cannot be called a sedative; it is probably only weakening.

Irritability.—There is no word perhaps more improperly applied than irritability; it is often used for stimulus, and stimulus often used in place of it. Indeed we must allow that there is a resemblance between them in several of their properties, both exciting actions of the living parts; but they differ very much in the consequent action, as, indeed, irritability appears to be nearly allied to susceptibility.

I have already explained, when on the animal economy (p. 62), that stimulus excites or increases natural actions; but an irritation either excites an unnatural quantity of a natural action, or an entire new one; and susceptibility is the readiness with which they can be excited.

Some constitutions are so easily excited, or in other words, so susceptible of diseased impression, as to take up actions so readily as to make them appear natural, which in others are only brought on by disease. That a natural action may be increased beyond its natural bounds we see every day. Salivation is an instance of this. That irritation produces new action is perhaps more evident than the former. Accidents of all kinds are of this kind. Blisters act on this principle. In short, every new action which takes place may be said to arise from an irritation produced in the part, or something similar. Irritations are often producing salutary effects, and therefore may be said to terminate in a stimulus, which is owing to a kind of irritation, such as those which are in consequence of many accidents, which new action produces a restoration of the part injured, as in wounds, compound fractures, &c.

There are new modes of action taking place every day that would appear to arise spontaneously (therefore from no possible irritating cause, which, on the contrary, most probably arises from this new mode of action). The immediate cause may be so slight as hardly to approach to an irritation. Such constitutions are called irritable, which is only saying that one part may be irritated by what would have no effect on another. Those unnatural spontaneous actions often arise from a want of power to act properly, with a strong

disposition to action, which is the reason why weakness, or want of power, becomes the cause of irritation, which produces new action, which new action will be according to this want of power and the nature of the part combined.

Necessity often becomes the cause of irritation, as when a small opening is made into a large cavity, and not allowed to heal by the first intention, the whole becomes under the necessity of taking on a new action to restore the whole; therefore irritation often produces salutary effects.

Many of the preternatural actions are so slow in their motions that we can hardly make them accord with our ideas, which ascribe them to irritation, especially in those that seem to arise spontaneously, as the formation of many wens, encysted tumours, &c.

Irritation may be divided into common, specific, and poisonous: 1st, Common, is that which will affect all animals; 2d, That which will affect only the same species; 3d, Is also very much confined to species; one only, as far as I know, being excepted,—the bite of a mad dog. So that the disease of one animal, although communicable to another of the same species, is not so to one of another species. Small-pox, chicken-pox, venereal disease, measles, whooping-cough, jail-distemper, itch, scrofula, are peculiar to the human. The disease of black cattle is confined to them; the rot to sheep; glanders to horses; mange to dogs.*

CHAPTER X.

OF SYMPATHY.

Disposition to action arising from sympathy;—without direct impression.—Sympathy of two kinds;—connexion of principles of action in the living body;—sympathies of sensation doubtful.—Sympathy between different bodies.—Sympathy natural or diseased;—not always reciprocal between parts;—generally single;—common or uncommon;—similar or dissimilar;—partial or universal.—Varieties of partial sympathy;—varieties of universal sympathy;—fever, inflammatory, hectic.—Certain parts sympathise more strongly than others.—Of similar and dissimilar sympathies;—of simple sympathies; difference of sympathies from modes of impression.—Sympathy of body with affections of the mind;—of the mind with the living principle;—use of sympathies.—Of delusion;—explanation of it;—delusion in dreams.

I HAVE endeavoured to show that there are two principles in the higher animals, namely, life and the action of the nerves, which last is called sensation and volition; or rather, perhaps, there is but one principle, life, which becomes the basis of the other and of

* [There are some of the above diseases which are now known to be communicable to other animals.]

every action of the body. I also endeavoured to point out that sensation arose from feelings in the mind, which produce action in the body. I attempted to show that the more simple actions arose independently of sensation or of the actions of the nerves; that the nerves, from their specific actions, only become the cause of many actions, but are not the principle of those actions; that from their termination in the brain they produce sensations there from which is formed mind, and that they also give rise to the will, and form the basis of reasoning. I showed that the mind becomes the cause of many involuntary actions in the body, as reason becomes the cause of the voluntary; and that thus the actions of life, of the nerves, of the mind, and of the will arise from impressions being made on each so as to affect their principles.

In speaking of the general principles of disease, I divided the living power into susceptibility of impression, impression, dispositions arising in consequence of such, and action consequent on disposition; all which I observed were immediate or primary. But there is a secondary susceptibility, disposition, and action arising from, or in consequence of, all, by necessity, called sympathy; actions, as it were, playing amongst themselves, each becoming a stimulant to the other, or each being affected by the other.

By this principle of action, called sympathy, an action arises without an immediate impression in a secondary way, either acting in conjunction with the part immediately impressed, or taking the whole action on itself. This action without immediate impression is one of the most complicated principles in the animal body, especially the more complicated animals, because it is the compounding of actions.

Sympathy may be divided into two species: 1st. A local with a local disease; 2d. A universal with a local. The first may be called local sympathy; the second universal. But all sympathies must arise from a local cause. Sympathy is not confined to the same actions of the same person, but is transferable from one person to another.*

In the investigation of this subject, we shall find all the principles of action in an animal, even in the most complicated, have a connexion with one another; for instance, the living principle, the action of the nerves, and the mind: and that the same principle in one part shall be affected by the same principle in another; and this

* [For some curious examples of this sort, see Dugald Stewart's "Elements of the Philosophy of the Human Mind," p. 153, et seq., and Edin. Med. and Surg. Journ., vol. iii. p. 434, et seq., respecting the mode in which some convulsive diseases were propagated in Scotland. A strong collateral argument may be derived from this species of sympathy in favour of that opinion which makes the intervention of the sensorium commune a necessary condition to the existence of sympathy. See Whytt's Works, p. 140, and Dr. Alison in Edin. Med.-Chir. Trans., vol. i. p. 165. That the nerves, however, are capable of a reflex action through the medium of the spinal marrow as well as through the brain, is rendered certain by the experiments of Dr. Marshall Hall and by many morbid phenomena. See Med. Gaz., vol. ii., 1832-3, p. 769.]

is the simplest kind of sympathy I can conceive. Thus, the living principle of one part sympathises with the actions of life in another part, as must be the case in all animals which have no nerves.* The nerves of one part sympathise with the actions of the nerves in another, which may produce sensation. The mind sympathises with the mind, which of course can only take place in animals that have mind, and perhaps not in all of them; and it is more than probable that such minds as are capable of sympathy are capable of other complications of affections. Probably what might be called the disposition to action of one principle in one part may produce action of another principle in another part. Thus sensation in another part may be produced, while simple life only is affected in the part immediately impressed. This would appear to be owing to the nature of the sympathizing part. Thus, if an injection is thrown into the urethra in a man, it shall not give pain in the urethra, not even the common sensation of the part, yet the stomach shall be affected and sickness produced, which last is a sensation. I have known a stimulus in the rectum, which did not produce pain in the part, produce sickness and pain in the small intestines, and even stop digestion. Such pain certainly arises from action in the part. On the contrary, simple pain in the finger shall produce a greater action of the living principle in another part, as making the heart beat oftener.

The principle of sympathy itself I shall call a genus, of which the above make three species, namely, sympathy of the actions of life, of the nerves, and of the mind. Each of these have their varieties in action, each being susceptible of varieties of impressions, affections, and actions, and all being capable of sympathizing with one another.

It may admit of dispute, and probably will be difficult to settle, whether there is sympathy between sensation and sensation simply; for sensation must arise from some impression made on a part, or some action of nerves similar to those arising from impression. Therefore every sympathy which only produces sensation must still arise from impression on, or action of, the nerves; and the same with the sensation in the sympathizing part. Sensation is only the natural consequence of such action, for sensation is only the intelli-

* [What the real conditions of the organization are on which sympathies depend are unknown, although there seems every reason to ascribe this agency *solely* to the nervous system. To ascribe it to the living principle is merely eluding the question by a sort of abstraction. The difficulty still returns—what is the intermedium through which distinct and dissimilar parts are thus associated? Some intermedium there must be; and as to the difficulty respecting those beings which have no nerves (p. 54, note), the same is equally felt in regard to the higher animals, in which the most powerful sympathies exist, although no anatomical connexion is to be traced between the parts, nor any relation of function or structure observable. Indeed, those structures, such as fasciæ, membranes, &c., which apparently have no nerves, are those very parts which give rise to the strongest and most marked sympathies.]

gence of action, either from impression or arising from the spontaneous action of the nerve itself.

I suspect that all those which would appear to be sympathies of sensation only, without action, are a delusion of the mind, a wrong reference of the mind to some other than the part affected, which I shall explain when upon the subject of delusion.

From what has been said above, it must appear that sympathy is a principle in animal bodies so intimately connected with every possible impression, affection, and action, that we cannot have a proper conception of the animal economy respecting diseases without taking this principle into consideration. It is one of the secondary principles when applied to the body itself, being the effect of some impression, affection, or action in some other part of the same body. Sympathy arises from every part of the body being ready to fall into affections and actions in consequence of an impression, affection, or action having taken place in some other part. Sympathy is one part taking part in the impressions, affections, and actions of another part.

Sympathy is not confined to actions of the same persons amongst themselves, but is transferable from one person to another, in whom it cannot be called a secondary action, as it arises from an impression being made on some of the senses.

Yawning is a species of sympathy; and all actions peculiar to country, places, family, &c., are so many sympathies. Dancing may be included among the sympathies, for it is not simply an imitative action arising from the will, but it is an irresistible impulse arising from a state of mind produced by musical sounds. If there were no sounds, or, in other words, not a sense of hearing, there would be no dancing: for seeing would not produce it, probably rather retard it. There is, first, sensation; then a state of mind formed in consequence of that sensation; and then the action of the limbs excited by that sensation.

The idea of sympathy may be stated differently: instead of saying a part sympathizes with another, we may say one part under stimulus or irritation is capable of stimulating another part of the same body into sensation, action, &c., which I think is the most natural idea or position.

Sympathy may be divided into two kinds, the natural and the diseased. The diseased is when sound parts sympathize with the diseased, and probably the diseased with the diseased, which is what I mean to explain.

The sympathy of one diseased part with the diseases of another part will include the idea of revulsion, as revulsion consists in the production of a disease in one part to cure a disease in another part; which shows that this one part, while under disease, can be affected by a diseased action being produced in another part, or the cessation of one action in consequence of another having taken place in another part.

Natural sympathy takes place more readily, and its actions are

more strongly marked, in proportion as the powers of the machine are capable of repairing an injury received. On the other hand, it takes place more slowly, and is less evident, as the powers of life are more languid.

In many diseased states the condition of the whole body is often such that it more readily falls into sympathy at one time than at others. Thus we find people at particular periods much affected by slight causes, while at other times considerable mischief received will hardly affect them.

Some people are naturally more readily affected than others, as will be evident in disease.

Sympathy sometimes proves fatal, as in children from teething. But this depends in great measure on the parts sympathizing, or the number of parts that sympathize.

Sympathies are often not reciprocal: the liver never sympathizes with the shoulder, nor the urethra with the testis; nor when the glans penis is affected does any irritation pass to the bladder; but often they are, as, for example, between the head and the stomach.

Sympathies are generally simple; we hardly ever find two parts sympathizing with the same cause: however, the spasmodic convulsion of both hands and feet, &c., as sometimes takes place, may be called a double sympathy.

Sympathy is common and uncommon. The first is where it takes place more readily between some parts than it does between others, as between the stomach and head, the stomach and the skin, the testes and the urethra. Sympathy may be called uncommon when parts sympathize with diseased parts that were never known to sympathize in health.

A gentleman had a sore on the inside of his thigh, which itched so intolerably that he could not avoid scratching it, and when he did, it always produced tightness in his chest and shortness of breathing, which he never had but at these times.

Lord Cavendish's father always felt pain in the left arm from a stone in the bladder. This pain was the only indication of a want to make water.

Sympathies are either similar to the cause or dissimilar. The similar can be but of two kinds: where the modes of affection or action of the sympathizer are either wholly similar to the modes of affection or action of the parts diseased, or the sympathizer has one of its modes of affection or action similar, and which is the one that sympathizes. Dissimilar sympathy may be of so many kinds that it is probably hardly possible to be completely master of the whole of the particular varieties.

Sympathy may be said to be either partial or universal. Sympathy is partial, from local diseases, when the causes of action in one part become the cause of action in a distant part, as when anything tickles the nose the muscles of respiration act; or it may be partial from a universal disease. But local sympathy with the

constitution has its order of parts, as the stomach sympathizes with the whole body in an incipient fever.

Sympathy is either natural or diseased. Natural sympathy always tends to produce some salutary purpose, as the breasts of women increasing with the size of the uterus during gestation.

As no part of the body is entirely independent of the rest, in all particular injuries the whole must sympathize more or less; but as every individual part has a more intimate connexion with some particular part than with others, these parts sympathize more readily.

Local or partial sympathies we call continuous, contiguous, or remote. Continuous is only an extension of the same action, as in most inflammations spreading from the centre; otherwise, in an injury, the part which received the first impression would alone become inflamed. Contiguous is where one part sympathizes with another where the parts are only in contact with each other, without any continuity of parts, as the contents of the abdomen with the abdominal muscles.* Remote is where one part sympathizes with another part, though at some distance from it.

Universal sympathy is when the whole becomes affected in consequence of a local disease, and is of two kinds. One is where every part of the body sympathizes with any one part stimulated, as the sympathetic fever in consequence of local inflammation, as also eating substances that disagree with the stomach, convulsions from worms, teething, &c.; or, secondly, where particular parts, being stimulated, more readily produce universal sympathy than any other.

Constitutional sympathy may arise in many cases from local sympathy, and not from the effect of the first injured part. This is very remarkable when the sympathizing part is a vital part, though the first injured part be not vital. If the stomach sympathizes strongly with any part of the body, this sympathy of the stomach produces a morbid state of the constitution.

In universal sympathy there appear three stages, but all equally belonging to this principle; 1st, inflammatory fever; 2d, hectic fever; 3d, dissolution. These take their rise from the different stages of the local disease. There may be marked a fourth, which may be called nervous, spasmodic, or hysteric; but this is not particular to any one of the states of the local disease from which the others arise, but from peculiarity of constitution, and sometimes it exists when the others do not.

Local or partial sympathy is found more in old than in young; whereas universal sympathy is more in young than in old. Sympathy is less determined in young persons, every part being then ready to sympathize with other parts under disease. This is re-

* [Of this kind also are the actions of membranous muscular cavities, as the heart, stomach, or intestines, when their lining membranes are stimulated, and of the muscle of the skin in animals when the skin is irritated.]

markable in the teething of children, for in them universal sympathy seems the first mode of sympathy arising from local irritation.

When a local disease takes place in a part when the patient is very young, it is capable of giving a general disposition to sympathize, by which means symptoms become more uncertain than in those of more advanced age, often putting on the appearances of a great variety of diseases.

As the child advances, the power of sympathy becomes partial, there not being now in the constitution that universal consent of parts, but some part, which has greater sympathy than the rest, falls into the whole irritation; therefore the whole disposition to sympathy is directed to some particular part. The different organs acquire more and more of their independent actions as the child grows older.

We find in children the symptoms from sympathy often more violent than those of the parts affected. In adults when cutting teeth there is only an affection of the part, or only a continued sympathy, that is, a swelling of the cheek, &c. In adults the pain is often very great, but in children the pain is little, and the action of the part moderate, but the action in the sympathizing parts is very great, namely, in the voluntary muscles.

Sympathetic Inflammatory Fever.—In consequence of considerable local injuries, as a compound fracture, or operation of consequence having been performed, that accident or operation shall be followed by inflammation, suppuration, &c. In consequence of this local injury fever shall arise in the system, which is universal sympathy, commonly called symptomatic fever.

Convulsions often arise from considerable local injuries called irritation. Permanent contractions are also often the consequence of local injuries or irritation, as tetanus.

If another mode of action takes place in the part sympathized with, namely the cure of the injury, then the inflammatory sympathetic fever will subside.

Sympathetic Hectic Fever.—If parts have not a power to effect a cure, the constitution sympathizes in another way: it is teased, as if conscious that the disease is incurable; and this teasing constitutes the greatest part of what has been called hectic fever. But if this incurable part is removed, the hectic fever will cease.

I have seen a wound in the knee keep a man awake several nights with pain and constant purging, and the patient becoming hectic; and by amputating the part he slept well the same night without opium, the purging immediately ceased, and costiveness ensued. A man had a wound in the elbow-joint, and was affected exactly in the same way, the pulse quick and hard: within ten minutes after the removal of the arm the pulse became slower and softer.

This universal sympathy, of whatever species, is greater when certain parts are diseased. The sympathetic fever will more readily take place from an injury done to the involuntary parts, as

the stomach, intestines, testicles, &c., than if the same mischief had been done to the voluntary parts, as the muscles of the arm, for instance.

When vital parts are diseased, there is more sympathy among vital parts than among others.

Universal sympathy is greater if the injury received is further from the source of life, namely, the heart, than near it, provided it be a part of the same nature in both cases.

Sympathy is similar to sensation, action, motion, &c.: it can, and often does, cease instantaneously. Every sympathy ceases after the cause is gone, although its effects may remain, as tumefaction.*

Some parts of the Body sympathize more than others.—The stomach appears to have this connexion with the body more than any other part. It would appear that the stomach was the seat of universal sympathy, sympathizing with every part of the body, and most parts of the body sympathizing with the stomach.

Every part of the body seems to have some susceptibility of sympathy; but although there is universal sympathy between the stomach and whole body, yet the stomach sympathizes more readily with a complaint in the head than with one in the toe; more with the testicle than with many other parts. Also some parts of the body sympathize more readily with the stomach than many other parts, as the head, skin, &c. The skin sympathizing with the stomach is often very evident, from the effect some food has on the stomach, producing disease of the skin. A glass of cider in some shall produce a flushing in the face immediately; and spirits, in the end, we know, produce inflammation and suppuration over the whole face, called pimples, especially on the nose. But whether the stomach loses part of this property I am not certain. It appears that other parts lose that susceptibility to sympathize with the stomach, as the skin, for that part does not seem to be so readily affected in the old as in the young.

The stomach sympathizes with the skin in many of its affections. Cold or wet feet will immediately affect the stomach. But the most striking instance is seen in the leech when its stomach is full of blood, by throwing salt on it, when, from sympathy of the stomach with the skin, it immediately rejects all the blood.

The intestines, especially the upper parts, have also sympathies over the whole body. Cases of worms show this perhaps more than anything.

Observations on Sympathies of the different Principles with one another, producing similar and dissimilar Sympathies.—Continued sympathy is more commonly similar than the remote, as it is an extension of the same action, and commonly in a similar part which can act alike, as indeed most parts do in most of their common

* [It often happens, however, that parts acquire a *habit* from long-continued sympathy, which does not cease upon the cessation of the cause.]

actions, although the peculiar actions of the part may be dissimilar.* Thus, chancre on the scrotum, if it was to spread to the testicle, would produce the same mode of action in the testicle as in the scrotum, though it might at the same time produce effects peculiar to the testicle, as stoppage of the secretion, &c.

But the remote, local, or partial, is both similar and dissimilar, varying according to two circumstances: 1st, According to the nature of the part diseased and the nature of the sympathizer. 2d, According to the species of properties in each part; as one property in the part diseased producing sympathy in another property in the sympathizer: disease in one part producing increased natural discharge in another part, which makes sympathy very complicated.

Let us take sensation as an illustration: although we have no sympathetic sensation, it being wholly delusive, yet sensation is an absolute guide. We know that the sensations in the brain are not similar to any other sensations in the body, at least not similar to many of them; also the sensations of the stomach are unlike to many of the brain, if not to the whole of them; also that many of the sensations of the stomach are not similar to the sensations of other parts; also that all sensations of the stomach are not the same; also that an action of one part shall produce sympathy of another, whose mode of action is not similar: we must see therefore at once why the two modes of action become not similar, and why the sympathy is not similar to the cause, producing by this means another cause of complication, and consequently a variety in the first principles of sensation and action respecting sympathy. Again, difference of properties may produce dissimilar sympathies between two different principles, as the principle of life and that of action. For as sensation in one part may produce sympathy in a part whose actions are dissimilar from that other part, the sympathy produced will be dissimilar, and this resulting from the difference in the properties of the principle of action.

Also when we consider that many parts have more modes of action than one, as the stomach, which has a variety of actions, and of course is capable of producing a variety of sympathies in other parts, or can sympathize in a variety of ways with other

* [To this head may be referred, 1st, Those sympathies by virtue of which parts become successively diseased *in pairs*, as two eyes, two similar parts of the skin, or two testicles. 2d, Those which give rise to disease in consequence of similarity of *function*, as ulceration of the cartilages, inflammation of the synovial membranes of joints, &c. 3d, Those which affect particular organs from *forming parts of the same general system*, as disease of the bladder affecting the kidney, of the uterus affecting the breast, or the spinal marrow of the brain, &c. And 4thly, Those which arise from *similarity of structure*, as inflammation of fibrous and mucous membranes, &c.

We may observe, once for all, that any philosophical classification of sympathies is impracticable. Mr. Hunter has probably made his division of sympathies too complex; but he has amply redeemed this fault, if it be one, by the able manner in which he has treated the subject.]

parts, so that any one of these peculiar actions in one shall produce an action or sympathy in that suitable to the first action of the disease, which of course will be similar to the action of the diseased parts; while another action in the same part, and from the same principle, shall produce another mode of sympathy in the sympathizer; when we consider all these, they will at first sight appear inexplicable: as an illustration, we may observe what a variety of sympathies are produced from one mode of irritation, as teething, or worms in the intestines.

This connexion of every part of the body with the others, by sympathy, becomes one of the extensive principles of action in the animal economy, indeed is the basis of most of the compound impressions, affections, and actions.

Similar Sympathy.—Sympathy must be similar to the affection of the part first affected when between parts whose affections are wholly similar; similar in action when between parts whose actions are wholly similar.

Sympathy may be similar in disease when between parts endued with a variety of affections and actions, provided they are endued with the same affection or action, as irritation in one part producing irritation in another, which thus produces inflammation, as an injection into the urethra producing swelling and pain of the testicle.

Continued sympathy, I believe, in all cases is similar to the disease, at least the action is so, even though it may spread to a dissimilar part. If inflammation attacks the diaphragm, and extends to the liver from continuity, that inflammation of the liver will be similar to that of the diaphragm. The same also if disease extends from the testicle to the scrotum, &c.

Dissimilar Sympathy.—Sympathy is dissimilar when the affections or actions of the part impressed are not similar to the actions or affections of the part which sympathizes; thus, sickness at the stomach cannot produce sickness any where else; or, secondly, where parts diseased are susceptible of a variety of affections or actions of which the sympathizer is not; or, thirdly, even in parts where both the part diseased and the sympathizer are susceptible of the same varieties of stimuli and modes of action, which varieties in themselves are similar to one another, yet the sympathizer shall not be the corresponding affection or action to that which is excited in the part diseased; for example a medicine taken into the stomach shall produce flushing of the face or inflammation, though the stomach is liable to the same disease as that of the face, namely, inflammation. So that in this case the difference does not arise from the mode of action being different from that of the stomach, only that the face does not run on the same degree of action as the stomach. In inflammation of the liver the pain in the shoulder is different from inflammation, though the shoulder and liver are equally susceptible of inflammation. So that many parts have a variety of actions in themselves which are similar to some

actions in other parts; therefore sympathy shall or shall not be similar to the action of the diseased part, being according to the stimulus applied to such part, or mode of action of the diseased part joined with the mode of affection. Therefore simple stimulus, action, or affection shall not only be the cause either of similar or dissimilar action, but both, according to the variety of affections and different parts that sympathize. A stimulus in the testicle shall produce sickness in the stomach, which shall produce vomiting, which is an action; so that a double and different compound sympathy takes places from the same stimulus.

Of the simplest Sympathies.—In vegetables we evidently see actions taking place in consequence of actions having taken place in another part; but how far vegetables have a variety of properties and actions is not perfectly known; however, we can hardly doubt that they have a great many, for they produce a vast variety of effects, all these actions and effects arising from the principle of life. So that sympathies of vegetables may be complicated, and even dissimilar, but still more simple than the most simple animal. The succession of motions in a sensitive plant are no more than a succession of sympathies, or a succession of stimuli in consequence of those preceding. Here, then, we have an exact similarity in the actions of the sympathizers with the part first acted on.

The most simple sympathy is perhaps to be found in vegetables, these being much more simple than the most simple animal. Vegetables have the same properties as animals without brain or stomach. Take away, therefore, the sympathies of the stomach with the body, and of the body with the stomach, and those between the brain and the body, reducing the sympathies of the animal to the simple properties of life, and an animal will be exactly similar to a vegetable; and this I know from experiments made on trees.

The motion of the sensitive plant I have said is produced by a succession of simple sympathies: something like this may be found in the more imperfect animals; but no animal can be so simple in all its sympathies, though it may in some. I shall at present suppose that every part of an animal is liable to be affected by the stimulus of agreeable or disagreeable sensations, and the more simple the animal the more likely it is to be under the same simple sympathy. A polypus is the most simple complete animal, and therefore must be most similar in its sympathies; but I can conceive a child in the womb to be still more so, being capable of one stimulus only, namely, want in the system; and perhaps it has no sympathy even with this, as it has no demand on any part of its body for the supply. This simplicity of stimulus is found not only in the simple animals, but in some degree also in the more complicated. The similar sympathies may be compared to the union in sounds.

A polypus, though so simple an animal, is susceptible of four different stimuli, disagreeable and agreeable, propagation of the species, and want of repletion. In the last the stomach becomes

the original sympathiser, and produces action in the other parts, so that here is a sympathy as in plants, but not so simple, for the stomach first sympathises with the whole body when it wants repletion, and afterwards by a reflex sympathy the body is called into action and its little arms are erected.

Difference of Sympathies in the Sympathiser arising from difference in the mode of Impression.—Difference of affection and action of the sympathiser from that of the part affected does not always arise from difference in the nature of the two parts, but often from difference in the nature of the stimulant, or mode of impression; for a stimulant of one kind shall produce a mode of impression of its own kind in the part, from which shall arise a peculiar sympathy, while a stimulus of another kind will produce an impression of another kind, which of course will produce a sympathy of another kind in the part that sympathises. Thus, when the stomach is stimulated in a particular way, the head shall ache, which is often the case when something is taken which disagrees with the stomach; and if stimulated in another way the headache shall be removed, namely, by exciting vomiting.* There will be, therefore, a variety in the actions of the sympathiser, arising from varieties in the specific modes of action, created by different stimulants, which may also produce similar sympathy in dissimilar parts, for parts very dissimilar in their natural actions shall be put into similar actions by sympathy. When the stomach is stimulated in one way, an action shall be brought on in the muscles of respiration and of the belly for the expulsion of the irritating matter; or if stimulated in another way, sweating shall be brought on in the skin; or if stimulated in another way, universal debility takes place; a blow on the stomach may even kill.

Hence it appears, that a stimulus of one kind produces sympathy in one part of the body, while a stimulus of another kind applied to the same part produces sympathy in another part, each mode of action in a particular part having other parts distinct from each other which sympathize with it.

I should suspect that specific inflammations are not able to give to the sympathizer their specific virtues, though they may be liable to give them others. In *continuous* sympathies the affection is similar, but not in the remote. A swelled testicle in venereal gonorrhœa does not partake of the specific nature of the original disease. In a cancerous breast, the glands in the axilla will often inflame and subside again, which they would not do if they were affected with cancer.

Sympathies of the Body arising from Affections of the Mind.—The living principle of the body sympathizes with the mind. Strong affections of the mind will produce involuntary motions, even of those parts commonly at the command of the will. This must be

* [This illustration is incorrect; the headache is removed, not because another mode of stimulation, that of the emetic, takes place, but because the original one is removed; thus spontaneous headaches terminate in sickness, and get well.]

by means of the nerves, for the body has no connexion with the brain but by the nerves. Fear will produce action of the involuntary parts, as purging, discharge of urine, &c.

I suspect that particular parts may sympathize more readily with the mind than others; therefore in such cases sympathies may be called local or remote, but they are, I believe, in most cases universal.

Sympathies of the Mind with the Living Principle.—The third principle, mind, is capable of sympathizing with the first, or actions depending on the living principle, for I should think that a state of the body often forms a state of mind; however, it is not so readily affected by what does not produce sensation as by that which does. A man in pain not only feels pain as a sensation, but becomes depressed: or if the actions of life can produce sensation in any part, then the mind becomes affected, as when the whole body is in want of food the stomach sympathizes strongly with the whole, and the sympathy of the stomach causes a sympathizing mind. This is not sympathy immediately with the first principle, but sympathy with the sympathizer, or second, which, however, arose from the first. There are, however, instances where the mind sympathizes with the first, or life, for there are many instances where the mind is depressed without a sensible cause, called hypochondriasis, and also where the mind is light or easy without any sensible cause. I suspect that both these states arise from the living principle being either diseased or at rest.

Sympathy of the mind with the voluntary parts is curious. If the voluntary parts are rendered useless, the will has no longer any power over them; it produces a state of mind which prevents the will putting the parts into action. Thus, when the tendo-Achillis is divided, the person cannot put the muscles attached to that tendon into action by the will; but as soon as union takes place and grows strong, the mind allows the will to take possession of its action over the muscles.

*Use of Sympathies.**—Sympathies are designed for very important

* [To enumerate all the uses of sympathies in an animal body would evidently be impossible in the present state of science. Nothing is more certainly ascertained, however, than that every part of the frame is connected in some mysterious manner with the whole, and the whole with every part, in consequence of which a sort of community of feeling is established between all the parts and functions of the machine. This is most remarkably exemplified in those organs which are associated in some common function, as, for example, in the organs of generation, digestion, respiration, &c., which reciprocally act and react upon one another on all occasions, in health and in disease.

Ascending to still higher generalities, as, *e. g.*, to the great centre of organic life, the stomach, the brain, and the heart, the same relationship and dependence is observed to exist, still more strongly developed; while these again may be regarded as so many primary *foci*, to which all the impressions of the body tend, and from which, by a sort of reflex operation, they radiate to the most remote parts of the system. A balance of power and action is thus established which it is easy to see must be of the most essential importance to the general economy of the animal, whereby the weakness of individual parts is reinforced by the reaction

ends. They produce a communication between the three principles of the animal economy. The use of sympathy is often very evident. If there is an uncommon irritation in the lungs or throat, the muscles of respiration act with uncommon force, and the offending substance is thrown up. The irritation is frequently in the lungs, then it is transferred to the larynx, the muscles of respiration sympathize with the latter, and cough is excited either to get rid of the disease or of its consequence, which is increased and morbid secretion. In pregnancy the breasts become swollen, preparatory to their secreting milk in parturition. In labor the uterus is stimulated by the child, now become fit for expulsion, and the muscles of the abdomen sympathize with the uterus.

Sympathy in diseases, by becoming the symptom of disease, often leads us to the cause, especially when the cause is in a deep-seated part, as the pain in the knee when the hip-joint is affected.

We find that the sympathizer in some cases relieves the part irritated or under diseased action, as the testicle relieves the urethra; but there appears to be nothing gained by this, as the sympathy is the worse disease of the two.

By the sympathizer often relieving the part diseased, and sometimes even curing it, it becomes similar to a constitutional affection becoming a local one, as in the gout; and, as in the swelled testicle from gonorrhœa it often changes sides almost instantaneously, it is in this exactly similar to gout.

of the whole, or, on the other hand, the over-action of one organ divided and broken by participation with another. Upon this principle it is, also, that one disease becomes the cure of another, and that revulsives and counter-irritants operate. This *consent* of parts, or interchange of sympathy, in virtue of which the parts of a complex animal body vibrate, as it were, in unison, pre-eminently distinguishes an organized being from any work of human art, especially when we add to this the further fact that it carries within itself its own resources of repair whenever it is injured. The full perception which Hunter had of this extraordinary co-operation of parts led him to employ a language borrowed from the operations of the mind, as if *consciousness* resided in an animal body, and was capable of directing its operations as it were by *anticipation*. (See pp. 29, 49, 54, 58, et passim.)

The prevailing opinion is, that this connexion of function is established by means of the great sympathetic nerve, which is supposed to accompany the arteries in their most remote ramifications. Whether this is so or not is not susceptible of proof; we may at least venture to say that our knowledge of this set of nerves has hardly kept pace with other branches of physiology, and that in fact our actual knowledge of the subject is exceedingly imperfect. In the greater number of cases the intervention of the brain or spinal marrow seems to be an essential condition to the propagation of sympathy; and probably in those cases where this is not necessary, the same condition is fulfilled by the ganglionic masses of the sympathetic nerve. Nothing certain, however, can be affirmed on this subject.

Some physiologists have excluded from their definition of sympathy all those phenomena which depend on obvious anatomical connexion, functional relation, or continuity of structure, restricting the term to those cases only in which no functional or mechanical connexion is to be traced. I apprehend, however, that this distinction is not tenable, and that these two sets of phenomena will be found to depend on the same principle, and insensibly to merge in one another.]

Some sympathies are opposite in their action to the original action; pain in the liver is depressing, that in the shoulder rousing. Nature is incapable of sustaining the former, and sets up the rousing pain in the shoulder to continue life.

Delusion.—A simple sensation in the mind of a local disease in the body which does not correspond with the seat of the disease itself has, I believe, been always referred to the principle of sympathy. Thus, sensation of pain in the shoulder from disease in the liver has been always supposed to arise from the shoulder sympathizing with the liver. The sensation of the glans penis from a disease or irritation in the bladder has been referred to the same cause. But I believe it is a delusion in the mind; for the nerves of the part are not the seat of the disease, and irritation could not communicate to the mind the sensation of pain in the part affected, excepting they (the nerves) take on the same action, which they must do when they produce the sensation of pain of that part. But if the nerves of the part which is the seat of sensation in such cases do not act at all, it cannot be called sympathy.

That there is such a delusive principle in the animal economy we see every day, and that it not only exists between mind and body, so as to lead us astray from the real subject, but between the mind and other bodies with which it has no immediate connexion, not even by the common senses. But we must allow that certain sensations can form a peculiar state of mind, called a sympathizing mind, for we are capable of transferring the sensation of another person to ourselves, which is like a dream. A delusion in the mind is an object appearing to be where it is not.

To account for this delusion in sensation in ourselves may be difficult, but we may conceive it to be in this way. We may suppose that when the seat of sensation in the brain only takes on part of the action of sensation in the brain, it may be in this way:

Suppose E, (Pl. I. f. 3.) the brain; A B, two portions of the brain; G H, two nerves; F, communication between these two nerves; C D, two different parts of the body.

The nerve G is inserted into part of the brain A; the nerve H into the other part B. F is a communicating nerve between G and H. A and B are the two parts of the brain to which sensation from C and D is conducted. C is the disease or part impressed. But from the connexion between C and D, by means of the nerves G F H, B will become the seat of action of the nerve G as well as of the nerve H, and the sensation be in part referred to D as well as to C. For if the nerve H is stimulated, in consequence of these connexions, to take up part of the action of the nerve G, and B is sensible of it as well as A is of the sensation of C, then the sensitive principle of the nerves A B is made sensible of both the disease of the part of impression as also of the sympathizer D, which become the two impressions in the sensorium. If anything stimulates G, part of the action is communicated to H; this goes on with the action to B, so that both A and B become sensible of the disease

C. If there is disease in C, the mind is made sensible of it, because G always communicates the sense of C to A; but if a small portion of it is brought over to H, and this nerve carries on the action to B, B becomes sensible of it also, and B refers it not to C, but to D, because it is to that point that it has been accustomed to refer all its sensations.

I do not know whether this explanation may be the true one or no, but it is one mode of explaining how we may feel both the disease and the part of sympathy. But how is it in those cases where the sympathizer takes on the whole action, affection, or sensation? In this case we must suppose that not only a part but the whole of the sensation passes by the communicating nerve F to B, and thus the disease appears to be in D only. But it is possible that nervous sympathy is not affected by the nerves communicating with one another in the body, but from their connexions in the brain; as from the point B sympathizing with the point A, taking on the whole of its action, and referring its sensation to D.*

Delirium.—It will be very difficult to prove whether delirium is a disease of the brain or nerves; it appears equally easy to prove that it is from one as from the other.

A delirium is a dream arising from disease, whether the dream is in the brain itself or in the body; only it is worthy of consideration, as dreams arise from sleep, and as a delirium is a diseased dream arising from what may be called diseased sleep, whether it may not be first necessary to give a short definition of sleep.

Perfect sleep is a cessation of susceptibility of sensation, and of course of all its actions; the consequence of which is a cessation of consciousness in the animal of its own existence; and also, of course, of the consciousness of the relation it bears to itself and every other thing. But whether this cessation of the susceptibility of impression arises from the brain not then having power to receive impressions of the actions of nerves, or whether the nerves are not then capable of acting or conveying their action to the brain in the state of sleep, is not so easily determined.

Dreams are actions of the mind in sleep; therefore may be inde-

* [Thus, if a *branch* of a nerve be irritated (being in connexion with the spinal marrow), it is capable, by a reflective operation, of exciting all those muscles supplied by the *trunk*, although if the spinal marrow be destroyed this effect does not take place.

Sympathies of simple sensation are probably as *real* as sympathies attended with visible action, and to be referred to the same general law. This appears from the same cause producing one or both effects, according as the cause is *less* or more intense. Thus toothache and *tic-douloureux* will occasion pain *or* inflammation of the face; diseased hip will produce pain of the knee, *and*, as I have frequently seen, inflammation of that part; gonorrhœa will occasion pain *or* inflammation of the testicle; disease of the bladder pain *or* morbid change of structure in the kidneys. Many other examples might be adduced to show that the same cause is capable of producing simple pain *or* pain accompanied with visible effects: which is evidently inconsistent with the opinion which ascribes simple sympathetic pain to a misdirection of the mind.]

pendent of any immediate information or impression, but are always independent of the relative connexion between body and mind, or consciousness of the existence of that relationship between the two. For the connexion between the two enables the mind to distinguish perfectly what is sensation and what is only thought, without which all would be a dream. In a delirium, as in sleep, we find the susceptibility of external impression lessened. Whilst sensation is continued sleep is kept off; delirium may be also lessened by arousing the mind from that particular state by external impressions; so far delirium appears similar to dreams, but it widely differs in other respects. In natural sleep the more the brain puts on that peculiar state the less we have of dreaming; but the more the other state is put on the greater the delirium. Dreams often do *arise* from sensations of the body being conveyed to the brain, it being in an imperfect sleep; but the consciousness of the connexion between our own body and our own mind being cut off by the state of sleep, the sensation may or may not be referred to our own body; it may be referred to some other body.* In some cases it is not referred to the part of the body where the impression is made: and the same thing happens in delirium, where the connexion is cut off; these not distinguishing between real sensation and thought, what the mind thinks about appears to be real.

But even where the mind is in full possession of the consciousness of its connexion and relationship with the body, we have in some cases this delusion, as the appearance of the turning round of the objects about us whilst they are really fixed, and that in consequence of our having turned about quickly; giddiness from going to a height, or from riding backwards in a coach. Delusion is also an effect of intoxication and disease. Whilst awake and in health, impressions produce sensations, which are conveyed to the brain, and from these the mind reasons: but suppose the mind to

* [One of the most remarkable properties of dreams is, that we have no idea of time or place, or sometimes of our personal identity; in consequence of which we commit the most ludicrous anachronisms, imagine ourselves dead and alive, or in two places, at the same time, or else that our spirits have transmigrated into some other bodies. In consequence of the absence of external perception in sleep, the ideas and associations of the mind acquire an overpowering vividness which leads us to mistake them for realities; while the absence of reason and volition permits the imagination to revel in its own creations under the simple guidance of association. There are, however, many phenomena respecting dreams, delirium, and that variety of the former called somnambulism, which do not admit of any plausible explanation: the will, the senses, and voluntary motion are still exercised, under certain modifications; whilst it must be in the experience of every one that the reasoning faculty is still also capable of exerting itself, so as in some rare cases to engage in, and even to accomplish, the analysis of complicated problems which it could not have achieved during its waking state.]

There is one point in which pure delirium and sleep differ from insanity. Persons may be roused by a strong impression from the former to a right perception of their situation, whereas in the insane person truth and error are inextricably blended together, so that when seen side by side they are not distinguishable by the patient.]

have lost, or as it were forgot, its former connexion with our body, then the above false reference takes place.

A gentleman came into this country in 17—; his memory was imperfect, and a particular kind of delirium began whenever he was going to sleep, but afterwards continued whilst wide awake; and for a week before his death he was not quiet from this delirium a moment, but whilst his impressions were forced on him by external objects. His delirium was of this kind; he was constantly talking of former circumstances of his life, but referring them to the present moment and to some other person. There was a revival of past ideas in his mind, but from a want of connexion between his mind and his body, he was not enabled, by his present impressions, to infer how little relationship they bore to the present time, or to those persons to whom he referred them: at the same time, it really appeared more a want of connexion between the mind and the body than the mind itself being hurt, for he determined rightly what should be done in those circumstances which he supposed present, and would express his sentiments in really elegant language. That it depended more on want of connexion than on disease of the body, appeared, from his being sensible of impressions, and referring them to the part where they took place, but supposing that to be in any other body than his own. Thus, he would tell his nurse or the bystanders that they were hungry or thirsty; but upon offering food or drink, it appeared plainly by his eagerness that the idea had arisen from a sensation of hunger in his own stomach. He would show great signs of distress or anxiety, which he would say was because his nurse wanted to go to the close stool, but was restrained by his presence; and this from his sensations also. He had a violent cough, in which he would sympathize with some bystander, proceeding in his story after the cough, no otherwise disturbed than by sympathizing with the person whom he thought so unfortunate as to have it. The objects about him were more to him than his own sensations.

A gentleman who was fond of his bottle referred all his own weaknesses and feeling, as he became intoxicated, to those around him; and upon his going home would insist upon undressing all his family and putting them to bed, declaring that they were too drunk to do it themselves; and this happened not only once, but whenever he was intoxicated. I myself once experienced what I have since thought must have proceeded from this want of connexion between the mind and the body. I was reading a remarkable case, and reasoning with myself upon it, when I found the letters and words made an impression on the retina, but that I was incapable of affixing a meaning to them: this I thought might proceed from want of sleep; but that was not the case: I tried repeatedly, but without effect, and at last I went to bed, from which I did not move for three weeks, a violent affliction of the head following this extraordinary circumstance. It may not be amiss to say, that the case I was reading was that of the late Mr. Foote, who was not

able to command his attention to more than one action or circumstance at a time : thus, if he took his snuff-box out of his pocket and held it in his hand, it was all very well, until he attempted another action, such as taking a pinch of snuff out of it, and then the box fell immediately out of his hand : in fact, he was going back into a state of second childhood, for a child is not capable of commanding his attention to more than one circumstance or action at a time : give him a stick to hold, and call his attention to another object, and the stick will be dropped ; for it is by habit we become capable of attending to several actions at a time. If a person is blindfolded and put into a coach, he will think he is riding forwards though really moving backwards. An impression from any part, either healthy or diseased, may be conveyed, yet there may be no consciousness of the mind from which part of the body it was conveyed, the mind having full possession of the impression, and a perfect idea of it, but having nothing to direct it right in its reference of it. It must refer it somewhere, and is more likely to refer it to another than to itself. Thus, A (Pl. I. fig. 3.) does not refer the sensation to C as a cause, nor will B sympathize with A so as to refer it to D.

A gentleman, a medical man, dreamed he had given a patient too strong an injection for gonorrhœa, and that it had produced a total stoppage of urine : he awoke, and found an erection of the penis, and that he could not void a drop of urine. Here was an impression without the consciousness, and he referred the impression to another person.

A gentleman, upwards of ninety years old, suddenly lost his senses, and in consequence of this there was a reference of all the ails which he might be supposed to feel to his wife, who had been dead some time, but who he now thought to be alive, and ordering the utmost silence to be preserved, lest by noise her illness should be increased. The new-born child has probably sensation without this consciousness. The contrary takes place when a person refers the sensations of others to himself, or when the idea of sensation is supposed to be sensation itself, as happens in those who are affected by animal magnetism. I was asked to go to be magnetized, but at first refused, because the spasm on my vital parts was very likely to be brought on by a state of mind anxious about any event. Thus, at my country box I have bees, which I am very fond of, and I once was anxious about their swarming lest it should not happen before I set off for town ; this brought it on. The cats tease me very much by destroying my tame pheasants, partridges, &c., and rooting up my plants. I saw a large cat sitting at the root of a tree, and was going into the house for a gun, when I became anxious lest she should get away before my return ; this likewise brought on the spasm ; other states, where my mind is much more affected, will not bring it on. Now I feared lest my anxiety for the event should bring on the spasm, and that should be imputed to animal magnetism. But considering that if any person was affected by it it must be by the imagination being worked up by attention

to the part expected to be affected, and thinking I could counteract this, I went; and accordingly, when I went, I was convinced by the apparatus that everything was calculated to affect the imagination. When the magnetizer began his operations, and informed me that I should feel it first at the roots of my nails of that hand nearest the apparatus, I fixed my attention on my great toe, where I was wishing to have a fit of the gout; and I am confident that I can fix my attention to any part until I have a sensation in that part. Whenever I found myself attending to his tricks, I fell to work with my great toe, working it about, &c., by which means I prevented it having any effect on me.

CHAPTER XI.

OF LOCAL AND CONSTITUTIONAL DISEASES.

Difficulty of distinguishing between strictly local diseases and local diseases arising from constitutional affection.—Diseases constitutional;—local;—mixed.—The first universal, as fever;—or constitutionally local, as gout.—Local diseases.—Mixed diseases.—Diseases common or specific.—The latter do not always depend on a specific cause.—Of diseases peculiar to ages.—Effects of climate on diseases;—of seasons;—of temperature;—of the moon.—Of humours, erroneous notions of them;—effects of substances contained in the blood;—experiments of injecting medicines into the blood;—no specific diseases produced.—Of diseases supposed to arise from humours.—Of hereditary diseases;—hereditary nature of natural and of acquired properties;—hereditary dispositions;—latent hereditary principles;—similarity of children to their parents;—dispositions hereditary, but not diseases;—more permanent than accidental dispositions;—scrofula;—gout;—supposed hereditary.—Symptoms of disease local or universal;—variation of local symptoms;—universal symptoms affecting the circulation;—secretions;—nerves.—Combinations of symptoms.—Irregular symptoms.—Delusive symptoms.

It may be difficult in all cases of local diseases to distinguish between one truly local and one arising from the constitution; that is, one arising entirely in the part diseased, and one arising entirely from the constitution. For as one can and often does affect the other, which may be called mixed, it becomes the more uncertain where the disease originated.*

Diseases may be called constitutional, local, and mixed. Diseases may be originally constitutional and originally local; that is, diseases may take place in the same person from constitutional or local

* [Mr. Abernethy, in speaking of the evil effects arising from the separation of medicine from surgery, makes the following observation: "The effects of local disorders upon the constitution have in consequence been too little attended to; and, indeed, I know of no book to which I can refer a surgical student for a satisfactory account of those febrile and nervous affections which local disease produces, except that of Mr. Hunter." See his Essay "*On the Constitutional Origin and Treatment of Local Diseases.*"]

causes, and be totally independent of each other; but they may affect one another.

The first, or constitutional, is either a universal action of some kind, as fever, or where there is a universal susceptibility for an action, but the action is local. Therefore they are divisible into two kinds, 1st, universally constitutional, and 2d, constitutionally local.

Universally constitutional is when there is universal action of some kind, as fever, where every part of the body is under some diseased action, which will be according to the nature of the influence which produced the fever, as inflammatory fever, putrid fever, &c.

Those arising from external influence will in some degree reduce all constitutions to some one mode of action; and whatever difference there is between one and the other must only arise from a peculiarity in constitution.

If an inflammation is produced in any part by violence, it will always be as the constitution is. If a man has a fever, a cut will partake of the disease, and the inflammation will be erysipelatous,* or so on, according to the fever. But if the fever is of some specific kind, superadded to the nature of the constitution, as small-pox fever, a cut will not partake of the specific quality of that fever, but will be exclusive of the specific quality. Nor will a cut on any part of a pocky patient be venereal.

Constitutional diseases are of various classes, which are known by their effects. A constitutional disease is a universal diseased action, as fever, every part taking on more or less of the diseased disposition. Such diseases, I apprehend, have no disposition for local action, though it is commonly supposed they have, as where fever produces abscess. This I hardly believe, though an abscess may form in the time of that fever, and is caused by it, or is an effect of that fever; but it is not an act of the constitution, according to our third division, therefore does not relieve the constitution of that fever. What I call an act of the constitution relieves the constitution, as gout falling on a part; but in abscess from fever it is only that this part has been so disturbed in the time of the fever that it has gone into inflammation and suppuration.

The second of the universal is the constitutionally local, that is, when there is universal susceptibility of body to produce peculiar local complaints, but not the action, till disturbed; requiring an immediate cause, which may at the time be either universally disturbing, as fever, or in the part only, as an accident. Thus the whole constitution may be affected with a gouty disposition, but the disease becomes local and is cured. We see constitutional or univer-

* [There are many exceptions to this observation, as, for instance, in several cutaneous diseases, gout, rheumatism, &c. These diseases may exist in an active state in some parts of the body at the same time that common inflammation is produced in other parts by accidental injury. On the other hand, the erysipelatous inflammation seems to give way to common phlegmon when incisions are made into erysipelatous parts.]

sal diseased affection excite local, as fever exciting scrofula, not as a termination of that fever, but because the part affected was partaker of the universal affection, and being disturbed by that universal affection or action, it took on the mode of action it was most susceptible of. It would do the same thing on being locally disturbed; therefore, as to its diseased action, it is the same whether it is disturbed as part of a whole, or only by itself. The scrofula goes no further than a susceptibility for diseased action, until it is brought into action by the local injury or constitutional fever.

Perhaps there is no term so vague or undetermined in the mind as the term constitutional. Universal action of every kind may be called constitutional, even when arising from some local cause, which I have called one of the mixed; or one capable of producing local effects, which we have also called one of the mixed. But a true constitutional disease is one arising, as it were, spontaneously in the constitution, partaking of the nature of the constitution itself.

Local disease I would consider in two lights; 1st, When it is a natural local action, being a kind of violence on a part, there being no constitutional local affection. In this case the disease takes on no specific quality of the constitution, either from the constitution having none, or the disease not being affected by it, being such as either arises from itself in a part from a local cause, and may take place in any constitution, or may be produced by accident or violence where the constitution was never affected. 2d, Which will more properly come under the head of mixed, where the local affection either affects or is affected by the constitution.

The mixed may be said to partake of the first and second, and is often the consequence of either, namely, original constitutional producing local, or original local producing constitutional; therefore they are often of two kinds, and such as may be called secondary actions either of the constitution or part, as universal sympathy with local disease, yet not what generally comes under the idea of common sympathy, as sympathy of part with part. Of the mixed, the first kind is where original constitutional produces local; the second where it influences local already produced. Therefore this kind is divisible into two species.

It may be difficult to say certainly when a constitutional disease really produces a local; but it may be set down generally that there will be a distance as to the time of appearance of the two diseases. The first of these two species is of various kinds, perhaps belongs more to specific diseases than to common, and is where the constitution from its nature produces a local one, and is necessarily relieved by it, by what I have called an act of the constitution. Of this kind are small-pox, measles, fevers producing critical abscesses, erysipelalous fevers, gout, &c., and on this is founded the doctrine of revulsion.

Local diseases produced by an act of the constitution may be illustrated, I think, by the growth of plants. A plant or tree appears to have a disposition and power of producing either only a

top shoot, or a number of shoots, called branches, which are according to the nature of the plant. If the top is cut off, then a new branch sprouts, and it serves as a top; so that the disposition is taken up by some other part most susceptible of action. The same thing happens in those plants which grow by branches. So that the removal of a part in action gives the disposition of action to parts not before disposed to act, but next in order of susceptibility.

The second of the mixed is where the original local produces constitutional, and which may alter the constitutional disease already existing, or cure it. This may be of three kinds.

1st, The immediate; 2d, Less determined as to time; 3d, The remote. Of the first there appear to be two; of the second but one, though it may appear in different forms; of the third probably only one.

Of the immediate we shall reckon that which is called symptomatic fever. Delirium I shall reckon the second, though it is not always the second as to time. The third or remote, is hectic, to which may be added symptoms of dissolution, which last stage may be the consequence of either of them, or of any other disease.

The first of these is generally called symptomatic fever, but I choose rather to call it sympathetic inflammatory fever. It is sympathy of the constitution with the first stages of local disease, which is the action of alarm on the constitution, rousing up its powers to produce action.

The second, or delirium, appears to arise from an affection of the brain or sensorium, producing sympathy of action of the brain with the nerves of the part; not sensation, as headache, but an action producing ideas without uniting sensation, which is therefore delusive.

The remote, namely, the hectic, is a sympathy of the constitution with local disease, but sympathy of another kind; it is sympathy with the operation of an incurable disease, where the constitution is conscious of inability of the part to perform a cure, by which means the constitution is at last, as it were, worn out, producing dissolution if not removed.

Dissolution is the last stage and consequence of all, whether local or constitutional.

Diseases are common or specific.—All diseases are either common or specific, but it is more than probable that most diseases have some specific qualities. A common disease is such as will attack every constitution, and perhaps every animal, and rather appears to be an increased action, as common inflammation, common inflammatory fever, &c.

Many diseases may be reckoned specific in their mode of action, though not in their cause. An ague is a specific action, but its causes are various. Gout is a specific action, but its causes are various. Cancer is a specific action, though its immediate causes are various; but it is capable itself of becoming a true specific cause,

by forming a poison. The cause of scrofula varies, though its action is specific. The remote cause of all is a greater susceptibility of such actions.

A specific is a peculiar mode of action, differing from every other mode of action. A true specific disease is one that probably cannot arise but from one cause, and which probably belongs only to morbid poisons; for although gout, scrofula, ague, &c., may be ranked among the specific, yet they can and do arise from a thousand causes.

There seems a specific susceptibility for those diseases in those that have them. But in poisons there must be a specific cause, which may be attended at the same time with specific susceptibility of such, as some have a greater tendency to small-pox than others.

Specific diseases are such as we cannot increase, for they always act with the full force of the readiness in which the constitution is at the time. If the constitution can be made more susceptible of action, the action will be increased.

Every specific disease has two modes of action—namely, the common and the specific,—joined to it. There are specific inflammations, specific suppurations; or, in other words, there are inflammations and suppurations with specific properties, or which have specific properties superadded; thus, in small-pox there is common inflammation, with the specific qualities superadded. Specific diseases may be either universal or local; universal, as fevers of particular kinds; local, as scrofula; others are mixed, as agues, rheumatism; and these admit of cure from a variety of medicines.

A circumstance worthy of notice takes place with respect to local specific diseases; parts appear susceptible of them as to take on their action so readily, that were it not for another very curious circumstance we might soon expect them to spread over the whole body; but the favourable circumstance I refer to is where the disease is spreading very fast, affecting parts which the disease has not yet touched, whilst in the centre this diseased action no longer takes place. Those parts which have already suffered this action appear to have lost their susceptibility of it, whilst the surrounding parts are contaminated by sympathy with those parts already affected: this property belongs to many, as erysipelas, herpes, &c. I have seen the same thing take place in ulcerated bubo, spreading over the whole belly and thigh, but healing in the centre. Another circumstance is to be added to what I have mentioned as hindering the disease from extending over the whole body, which is, that the constitution itself alters or loses that peculiar susceptibility before such an event takes place.

Different parts differ very much in their power of resisting diseases, as well as in the power of curing themselves, or getting rid of the diseased action and putting on a curative one: this seems to be according to the strength of the circulation in the part; where this is less the power is less; thus, there is greater power of resis-

tance in a muscle than in a tendon. But in specific diseases I should suppose there is little difference in this respect, in consequence of a difference in structure, although we know that specific diseases affect some parts more than others, as the small-pox affects the skin; the measles, the skin and surface of the lungs: whooping-cough and hydrophobia, the throat; &c.

Diseases peculiar to Ages.—Particular ages have their particular diseases. These diseases peculiar to age are perhaps more of the specific than of the common kind; and age is little more than a natural or remote cause, there being some immediate cause acting so as to produce the disease, as in scrofula. But this is not the case with all of them, *e.g.* cancer, for this appears often to arise without any peculiar immediate cause. How far particular ages are more or less susceptible of particular poisons we do not know.

The age of man may be divided into three parts: 1st, The age of growth; 2d, The stationary age; 3d, The age of decline. The first and last are absolute, but the second is not so easily ascertained, it not being very easy to say where the first ends and the last begins. The young subject and old are more susceptible of many diseases than the full-grown, or stationary, but they are not subject to the same diseases. The young are more susceptible of sympathy, both universal and local; more susceptible of scrofula than the middle-aged, but particularly more than the old: and this scrofula may produce consumption, which we know is peculiar to youth. Children are more disposed to have affections of the bowels, and worms, perhaps, from a peculiarity in their way of life. They are also more subject to water in the head than those who are older. The young have few affections of the mind, excepting those arising from natural passions, or immediate sensations of the body.

The middle age would appear to have but few diseases peculiar to it, excepting nervous affections and hypochondriasis, &c. The middle age gets into an imaginary region, a region of romance, which produces diseases of the mind, and also affects the body. However, it is, as it were, accidentally affected with the diseases both of youth and age, with which it is gradually intermixed. The foundations for the diseases of old age are often laid by intemperance during the middle age.

In the old we have perhaps as great a variety of diseases as in the young. In the old the power and necessary action are not well proportioned, even in health, much less, therefore, in disease. This produces a degree of irritability often increasing inflammation, and terminating frequently in mortification. In the old we have the gout, which seldom takes place in the young. Cancer is peculiar to the latter part of the middle age, and still more to the old. Gallstones are to be found chiefly in the middle-aged and old. Ossifications of arteries are rarely found in young persons. The bladder becomes less disposed to stretch, and more irritable; hence old people make water oftener than young. The prostate gland is more subject to indurations. The mind gradually becomes more

attached to [Quære, *detached* from?] this world and the things that are in it the nearer it approaches to a separation from it.

Effects of Climate on Disease.—Climate in general only becomes the immediate cause of disease; however, it is sometimes sufficient to produce the whole disease. Climates are of three kinds: hot, cold, and temperate. Hot climates carry on the natural operations, both of animals and vegetables with much more rapidity than either of the others.

It is almost impossible to rear young animals in cold weather; therefore most animals bring forth their young in spring and summer. Animals of the same species do not grow to the same size in cold climates as in warm. It is almost impossible to fatten an animal while it is kept in the cold.

Warmth produces action beyond its power of generating strength.

Parts more readily yield to any power in summer than in winter. Mr. Jones, the inventor of the machine for correcting distorted spines, observes that they produce more effect in summer than in winter.

Hot climates produce diseases in the liver, but these diseases are more frequent in the West Indian islands than on the continent of South America or India.* They also produce violent vomitings and other disorders in the stomach; also violent affections of the bowels: and fevers and diseased actions, like the natural, are much more rapid than in temperate climates, it being no unusual circumstance for diseases to run through all their stages in a few hours, ending in death, which is speedily followed by putrefaction. Heat produces indolence in the voluntary actions, which is injurious to health, but generally increases the involuntary action or actions of life, which is always hurtful. Cold climates retard many actions, both of vegetables and animals; but cold, when only in a certain degree, and continued for a certain length of time, excites action; but that is the action of strength, the action of resistance or defence, not the action of luxury or ease. Cold climates produce their diseases, though it would appear that they have not equal effects with warm, nor are capable of producing such variety. Whatever diseases are produced by cold are not so rapid as those produced by heat; and after death putrefaction does not take place so rapidly. We may observe a curious gradation in this process; in cold climates, after visible death, absolute life will remain for some time; the muscles will retain their power of contraction, and the blood be kept from coagulating. But in hot climates death is as rapid as disease; for it is action that consumes life. In cold the action is less: in heat it is so great that the body can hardly support it, and death comes on. Cold climates lead to voluntary actions, which generate heat, and this is much more healthful than heat derived from external sources.

In temperate climates there is perhaps a greater variety of

* [The very reverse of this observation is, I believe, the fact; see p. 86.]

diseases than in either the hot or the cold ; for the temperate is a very irregular medium, sometimes very hot, sometimes very cold, and often in the middle state ; and these changes are not at regular periods. This irregularity produces some irregularity in the wetness or dryness, so that in such climates we have a great mixture. These changes] in temperate climates give rise to scrofula, colds, &c., which are the forerunners of a thousand diseases. Agues are also much more frequent in temperate climates.

Seasons.—Seasons which arise from the variations of heat in a climate, produce diseases which will be in some degree similar to those both of hot and cold, and also temperate climates ; for seasons are, as it were, a change from one climate to another. Seasons have besides, diseases peculiar to themselves ; they produce an increase of old diseases, arising simply from the change, and call forth those diseases which only want an immediate cause to produce them. The spring and autumn are two of the most unhealthy seasons in the year : the spring the most so, although from reasoning alone, without observation, it is supposed to be the most healthy, and therefore people do in the spring whatever will allow of a choice of time, as inoculating, &c. This idea probably took its rise from observing vegetation, that at this time the plants appear to come into life and action. But, even in vegetables, this season is the most unhealthy ; blights much more frequently take place in spring than in summer. Of every disease that can be called constitutional, that is, where there is a strong susceptibility for such disease, we find spring becomes the immediate cause, exciting it to action ; thus, scrofula shows itself, or increases in spring ; the same with rheumatism and scurvy ; hence spring is said to set the humours afloat by those who are favourers of the humoral pathology.

I should doubt much whether there is any diurnal influence on our body, further than that which the habitual modes of acting produces ; consequently, I doubt if daylight or darkness produces any effect. It is, however, certain that the increase of action which commonly takes place in the day, increases diseased action, producing exacerbations in continuous diseases. It is probable, therefore, that it may bring on the paroxysms of those diseases which are periodical, and may bring on the first fit of a disease for the same reason.

Effects of the Moon.—The moon has certainly considerable effects on the human body. We find it often become the immediate cause of diseased actions, especially those of the mind. Mad people are certainly more affected at particular periods of the moon than at other times. The full of the moon has the greatest effect : it not only affects those who have a natural predisposition, but also some who have had injuries done to the brain by external violence.

A lamp-lighter, by a fall, injured his head : upon examination I found a fracture which appeared to run through the foramen magnum of his occiput ; he recovered, but he was seized every spring

with a phrenzy at stated intervals, and this was found to be at the full of the moon.

A gentleman had an anchylosed knee and ankle-joint from scrofula, and he is always deaf at the full of the moon, except in autumn, when his sores discharge plentifully.

This effect of the moon is increased at certain seasons; in spring it is greatest often. Intermitting and remitting fevers often arise, recur, or become exasperated about the time of the full or new moon, more especially in climates fitted for giving rise to such diseases.*

Of Humours.—The term humour has been applied to the animal body, especially the human, both literally and metaphorically. When literally, it is used in two senses, either as expressive of an extraneous substance existing in the blood, or as meaning the blood itself. When used metaphorically it is applied only to the mind, and is therefore more applicable to the human than any other animal.

Nothing can be more vague, nothing more unphilosophical, nothing more misleading in science, than to employ the same term to express two or more different meanings. In whatever sense the term is used, however, whether as applied to the mind or the body, it always is meant to express the cause of an unnatural or uncommon action or effect.

At present we shall only consider humours in their literal sense, in order to ascertain how far the notion is just or imaginary. I have just said that the word is used in two senses, either as something in the blood, but foreign to it, or else as implying a vitiation, of the whole mass of the blood itself. Among physical people we find such expressions in common use as “the humours are afloat in the blood;” “sharp humours in the blood;” “the whole humours being in a bad state;” “the whole blood must be altered or corrected;” and a variety of such expressions without meaning. They even go so far as to have hereditary humours, as gout, scrofula, &c., and make us the parents of our own humours, saying that we breed bad humours. Accidents, or even the application of poultices, have been supposed to bring bad humours to a part, because the part in which the accident happened, or to which the poultice was applied, would not readily heal. Humours are even supposed to gravitate to the legs slowly; and, in short, the whole theory of disease has been built upon the supposition of humours in the blood, or of the blood itself being changed. I cannot conceive what is meant, unless it be that a strong susceptibility to a specific disease exists; as small-pox may bring on scrofula, or a strain the gout; if in these cases by humour is meant a susceptibility of either of the diseases, I can conceive that any kind of accident may bring it on. The small-pox introduced may excite action, and so bring on the scrofula.

* [Dr. F. Balfour has fully confirmed this observation as to the effects of solar influence on the bilious remittent fevers of hot climates.]

I shall now consider the notion of humours afloat in the blood. If I have a just idea of the meaning of this expression, it signifies something extraneous or foreign, something that does not belong to the blood itself. That foreign matter is received into the blood-vessels is certain, and that so received it produces disease is also certain; but simply foreign matter being introduced into the blood, either produces no effect or no permanent and specific disease; the constitution, or some part, can be disturbed only as the constitution or part would be disturbed from any accident. Medicines, applied either externally or internally, is a proof of this, for all enter the circulation more or less, therefore are in the state of something extraneous, or of humours in the blood. Indeed, chemical analysis of the blood shows the existence of foreign matter, for it discovers substances that form no part of the animal, as sea-salt, iron, earths, &c.; yet these substances produce no ill effects by their presence.

The following experiments show the effects of foreign substances in the blood:

Experiment 1. I injected into the crural vein of a dog, towards the heart, a weak solution of sea-salt, which produced no effect. I then made as strong a one as possible and threw that in also, but no effect was produced. The quantity of salt thrown in might be about two teaspoonfuls.

Experiment 2. I threw a strong solution of Glauber's salts into the vein of a dog—about two drachms of salt. It produced no effect. The dog ate and drank and had his stools as before.

Experiment 3. Two ounces of a saturated solution of salt of tartar thrown into the vein of a dog had no effect.

Experiments 4, 5. Two drachms of sal polychrest in solution produced no effect.

Experiment 6. An ounce of water, in which a scruple of borax was dissolved, was thrown into the veins without effect.

Experiment 7. An ounce of vinegar and water, in equal proportions, was thrown into the veins of a bitch half gone with pup. This brought on an immediate disposition for miscarriage, which took place in about six or eight hours.

Experiment 8. Water, rendered about as acid as the vinegar and water, with vitriolic acid, was thrown into the veins, and produced little or no effect.

Experiments 9 and 10. The same experiment was made with nitric and muriatic acids with the same result.

From the above experiments it is evident that substances of considerable power may exist in the blood and produce little or no effects of any kind. We shall find from other experiments, that there are many substances which have considerable effects when thrown into the blood; still, none of them produce any particular disease, though by repeating them, and increasing the quantities, a man may destroy his health, or even his life, by destroying the natural actions of the body.

But all this is not producing any specific disease; it is reducible

to the effects of local applications, which is similar to an accident, producing no specific or permanent disease but what an accident would do, nor lasting any longer than the application lasted.

Experiment 11. I threw about two teaspoonfuls of a strong solution of opium, two parts water with one of opium, into the crural vein of a dog. The dog seemed to be very sensible of it at first, for he was extremely uneasy, and soon became convulsed, but did not lose sensation, for when touched he started and seemed frightened, and drew back his face when a hand was presented to it; so that irritability was rather increased. I then threw in as much more, which made him still more quiet, and in great measure produced loss of the use of his limbs, so that he could not stand; his breathing became slow and laborious, but his pulse very quick; when he attempted to get up he reeled, and came down as if asleep or drunk.

Experiment 12. I threw into the veins of a dog two teaspoonfuls of common gin. He showed no sense of uneasiness, but became soon vastly quiet, and not in the least irritable, showing no signs of fear when touched. He seemed wholly relaxed; his breathing was easy, and his pulse slow. He continued above an hour in this way and then began to recover.

Experiment 13. I threw about two teaspoonfuls of laurel water into the veins of a dog. The pulsation in the vessels became tremulous; he seemed very ill, and could hardly raise his head, but he recovered.

From these last experiments it appears obvious that many substances, having peculiar modes of stimulus, will, when taken into the blood, produce their effects there; but this effect will last no longer than the presence of the stimulus; and we shall find in general that their effects in this way are similar to what they are when taken into the stomach. We find also, by the above experiments, that many substances thrown into the constitution by the veins produce the same local specific effects on the intestines with those produced by the substance when taken in by the mouth.

Experiment 14. I threw into the veins of a dog an ounce of infusion of ipecacuan, made with five grains of the powder to two ounces of water. The dog immediately became very sick, and was retching before I could untie the mouth, and as soon as it was untied he threw up all that was in his stomach. He continued sick for some time, and gradually recovered. I can hardly suppose that the injection had gone beyond the heart, or even to it, when it began to act.

Experiment 15. An ounce of infusion of jalap, made with twenty grains of jalap to two ounces of water, and steeped for twelve hours, was thrown into the veins of a dog. In less than a minute he vomited a little and then seemed well. Thinking that no more effect would be produced, I threw in the remaining ounce. This did not produce any vomiting, nor did he at first seem much affected; but at last he grew weak on his legs, lay down at times, and then rose again. About two hours after the infusion was

thrown in he had a stool, and after this another, which was loose. He remained sensible the whole time and then got well.

Experiment 16. In a similar experiment the dog vomited, had some loose stools, and in a few hours got well.

Although many substances do produce similar effects on the stomach and intestines when thrown into the blood as when taken by the mouth, as appears from the above experiment, yet this is not the case with all. In the second experiment, for instance, we find that Glauber's salt had no such effect when thrown into the blood as when taken into the stomach. In like manner,

Experiment 17. An infusion of rhubarb, thrown into the veins of a dog, produced no effect but that of increasing the urine, which it did plentifully,

Many substances thrown into the blood produce much more violent effects in this way than when taken into the stomach, and even cause immediate death.

Experiment 18. I threw into the veins of a dog a little æther, and he died immediately. On opening the body the thorax had a strong smell of æther. However, this effect may depend on the strength of the medicine, as we shall see by the following experiments that the reason why death did not take place in experiments 6, 7, 8, 9, was the weakness of the solution.

Experiment 19. I threw some common vinegar into the veins of a dog, towards the heart. He died before I supposed it could have got to the heart. Now vinegar, when diluted, as we found before, had no such sudden effect. In the same manner, nitrous and vitriolic acid, diluted, to about the strength of vinegar, produced almost immediate death.

Air killed immediately. We should therefore be very careful in making experiments, when we inject substances into the veins, that air does not enter with the substances, and cause the death which we impute to the latter.* The Abbé Fontana committed many errors in this way: in short, before any man pretends to determine what will kill, he ought to have killed at least a thousand animals. A poor devil† was lately hanged at Warwick upon no other testimony than that of physical men whose first experiments were made on this occasion.

Experiment 20. I threw into the veins of a bitch half gone with pup a quantity of serum, taken from the blister of a person who was ill of a putrid fever, and soon after died. It made her instantaneously sick, and she vomited. She soon miscarried, but in two or three days recovered perfectly.

From all these experiments we may, I think, at least draw, as a probable conclusion, that extraneous matters taken into the constitution do not produce any specific or permanent disease, that they

* [Air in small quantities, introduced at once, or even in large quantities gradually admitted, is not generally fatal. See Treatise on the Blood, &c.]

† [Captain Donellan. For an account of this transaction, and of Hunter's evidence on the trial, see Life, and the Appendix to the Life.]

operate as direct stimuli, producing immediate effects, and that when these are violent they arise from too great a quantity of the stimulating or irritating substance being thrown in.

Poisons come nearest to the idea of humours, but still are not what is meant by humours, nor have ever had this term applied to them. Natural poisons will act somewhat as the substances used in the foregoing experiments did, that is, either stimulate the whole, or part, to increased natural action; or irritate the whole, or part, into some unnatural action, but which will last no longer than the poison is present. The sting of a bee affecting some more than others demonstrates that there is a greater susceptibility in some for such actions than in others, and that it cannot be imputed to humours in the blood, unless we could suppose a humour similar to the poison of a bee, which then might act without that cause.

I suppose that bugs bite everybody, but some they do not affect and others they do.

This is not so readily demonstrable in the poisons that enter the constitution, though even they cannot be said to be assisted by any humours in the blood. Other poisons, which we call morbid, produce a specific disease similar to the original; but all this does not come up to the idea of humours. A humour is something which is supposed to go on teasing the constitution if not extracted, and is even supposed to be capable of leaving one part and going to another.

What comes nearest this idea of a humour, but only so in its effects, is a surfeit; yet though its effects may resemble those which are entertained of humours, we know from the mode of their origin that they are not caused by a humour. It is a mode of action taking place in the skin from a stimulus or irritation being applied to the stomach. Drinking cold water when a person is hot will produce it. In a similar case, I have seen inflammation come on in the heart and lungs; but they being less able to bear the action than the skin, it proved fatal.

The method of cure of those diseases supposed to arise from humours gives us no idea of the disease having arisen from extraneous matter in the blood-vessels. Can we form any idea how bark should extract humours, when it rather stops all evacuations? And yet it cures many diseases. Would bathing in the sea cure those eruptions of the skin which are supposed to arise from humours if they were really caused by them? Can we suppose that electricity extracts any humours, when it cures an ague?

It is not easy to account for the blood having been supposed to be the cause of disease, excepting from it appearing in a bad state after bleeding, and this is always a *secondary* symptom. Sometimes, when this diseased state has not been very great, medicines have been given to sweeten the blood.*

* [In connexion with this subject, it may not be uninteresting to mention the following facts, which prove that the blood is capable of being greatly vitiated,

On Hereditary Diseases.—Hereditary, in the animal economy, is applied to properties or peculiarities communicated from the parent to the child.

This principle, according to the common notions, may be divided

either by the actions of the body or by foreign substances being introduced into it.

An animal body may be divided into those parts which form and those which consume the blood. The former consist of those organs which minister to digestion, sanguification, &c.; the latter, of those structures which perform the offices of nutrition. Increased action also (although perhaps always attended with increased nutrition,) rapidly induces an alteration in the qualities of the blood, and renders a more frequent renewal of it necessary. Whatever, therefore, influences the regularity of those processes upon which the formation and consumption of the blood depend, so as to destroy their just balance, must necessarily influence the constitution of this fluid. The following observations, drawn from disease, serve to confirm this view of the subject.

In the first place, then, the varieties in the aspect and sensible qualities of the blood prove that the condition of this fluid varies remarkably under different circumstances, being either buffy, firm, soft, diffuent, tarlike, or wholly incoagulable. It is of various colours and odours; it requires different times for its coagulation; it putrefies sooner or later in one case than it does in another; and the relative proportion of its constituents is very different in different cases.

There are, however, other changes to which this fluid is subject which are not equally obvious to the senses, but which are rendered evident by their effects on the body or by chemical investigation. Thus, urea has been detected in the blood in cholera, in certain cases of dropsy in which the urine is albuminous, in considerable abundance in cases of suppression of urine, and in dogs in which the ureters have been tied or the kidneys extirpated; sugar in cases of diabetes; and cerebriform, and melanoid matters in persons suffering from these diseases. The injection of putrid or ill-conditioned pus into the blood is found to give rise to a train of symptoms resembling those which are produced by inflammation of the veins, so as to render it highly probable that pus is taken into the blood in the latter cases; but as this is an important point, I shall offer the following considerations in proof of the fact.

1st, Pus is frequently formed in the cavities of inflamed veins and lymphatics at the same time that these vessels are perfectly open towards the heart. 2d, Pus is frequently found in the lacteals in ulceration of the intestines. 3d, Large abscesses are sometimes observed to disappear suddenly, which could not happen except the pus were taken up by the absorbents and carried into the circulation. 4th, In inflamed veins, small-pox, and *secondary* inflammations, there is reason for believing that pus is taken up and deposited in distant organs, as if by metastasis. 5th, Immediate relief of the constitutional symptoms ensues when ill-conditioned abscesses are laid open. 6th, M. Gendrin has observed a mucous sediment (*couche muqueuse*) in two cases at the bottom of the vessel containing serum, in the first of which the patient was affected with empyema, and in the second with a large abscess of the thigh. 7th, MM. Duploy, Andral and Rostan have noticed other cases in which the blood, throughout the whole venous system, appeared to have undergone spontaneous purulent decomposition, to which head may also be referred those cases of polypoid concretions in the vessels in which a purulent fluid is found in the centre, generally occurring at the same time with suppurative inflammation in some other part of the system. 8th, The physiological fact, that the actions of absorption and deposition antagonize each other, and are continually taking place in all the shut sacs of the body, which is proved by the rapid disappearance of injected matters.

M. Lecanu has detected the colouring-matter of the bile in the blood in cases of jaundice, which is well known to tinge the structures and secretions of the body of a yellow colour, and to give rise to drowsiness and other symptoms. M. An-

into two kinds: the transmission of natural properties, and the transmission of diseased, or what I shall call acquired or accidental properties. The last is not hereditary in all its causes, for it always requires an immediate cause before the action will take place;

dral has referred to cases in which the principles of the bile were found to be accumulated in the form of depositions in several organs of the body. Many cases are related of vicarious discharges, especially of the urine, and menstrual discharge, when the organs which afford these secretions have been obstructed. In cases of obstructed lactation, M. Dance observed symptoms referrible to the absorption of the milk, of which sort is a case described by Professor Graaf, in which a substance exactly resembling caseum was found in the fluid of an ascites, brought on by suppressed lactation, although in a subsequent tapping six weeks afterwards no caseum was discoverable. Milky serum, depending on the presence of oleaginous matters, apparently diffused through it in the form of an emulsion, is not uncommon, while Blumenbach considers it as not improbable that the ferocity of animals during the rut, as well as man's superior courage, greatly depend upon the reabsorption of secreted semen into the circulation.

Besides these instances, there are others of a still more obscure nature, which have chiefly been insisted on by the humourists. Gout and rheumatism, for example, used generally to be referred to a vitiated condition of the blood; an opinion which is certainly favoured by the constitutional and, above all, the metastatic nature of these diseases. In the former there is a disposition to secrete uric acid in superabundance, both in the urine and in the neighbourhood of the joints; a highly azotized principle, corresponding to the highly azotized nutriment which is known to predispose to the arthritic diathesis. In the latter the cutaneous discharges are known to manifest a peculiar acidity. The formation of calculi, the tendency to ossific depositions, and the disease called scurvy appear to depend upon the superabundance of particular salts in the blood. Duhamel has related cases of the most violent effects, followed by gangrene and death, depending upon inoculation with the *blood* of overdriven animals or of persons labouring under putrid forms of fever. M. Gendrin inoculated a cat, and on another occasion a dog, with the *blood* of a patient labouring under a putrid fever with eruption of gangrenous pustules, both of these animals soon after dying with analogous symptoms. Dupuy and Leuret have recorded many similar instances in regard to the horse. The following case was related to me by Professor Coleman, and is an interesting proof of the manner in which disease may be communicated through the medium of the blood. One of his pupils having accidentally inoculated himself whilst dissecting a glandered horse, was taken ill, with a set of anomalous symptoms, for which he was bled. The blood which was drawn was injected into the veins of a healthy ass, and produced the same disease in it as in the horse, notwithstanding that every precaution was used to obviate the possibility of any source of error. Mr. Hunter has related a case in which a child was born with the variolous eruption, and I have myself known a case in which a woman had seven children in succession (six of whom died) affected with venereal blotches on the nates a few weeks after birth, although she herself had been married upwards of ten years, and during that period had never been affected with any syphilitic symptom, although she admitted that she had had the disease previously. These and similar facts incontestibly prove that the blood is capable of being vitiated by the actions of the economy, in consequence of which it is rendered capable of propagating disease to others as well as of perpetuating it in regard to its own self. The following are some further instances calculated to show the influence of the nervous system in producing these effects.

Dupuytren found that the change from venous to arterial blood was not effected in the lungs when the eighth pair of nerves was divided; Dupuy, that the fibrin was relatively diminished by the same operation, at the same time that the blood was so much altered in quality as to give rise to dangerous symptoms when injected into the veins of other animals; Mayer, that the fibrin and hæma-

therefore its cause is not similar to the first. To produce an exact hereditary effect, there must be an hereditary cause or causes; and as in all animals of distinct sexes, in their propagation, there are two causes acting to produce a third, the first and second causes

tosin had a disposition to separate under the same circumstances, and the blood in the whole pulmonary system to coagulate. The coagulation of the blood in mortified limbs, the stagnation of the circulation in inflamed capillaries, the incoagulability of the blood in cases of sudden death, and the spontaneous concretions which sometimes take place in the living veins, are also to be regarded as proofs of the influence of the nervous system.

But the blood may be vitiated by extraneous matters. The existence of many of these substances in the blood is *inferred* from their effects, but we have distinct chemical demonstration of the presence of others. Among the former we may reckon madder, which tinges the bones of a pink colour; the alkalies and acids, which correct the opposite states of the urine; ergot, which produces gangrene; salt provisions, or the long-continued use of the alkaline carbonates, which produce the sea scurvy; mercury, which excites ptyalism; arsenic, which inflames the stomach; turpentine and asparagus, which communicate their odour, and rhubarb and many other substances their colour, to the urine. Alcoholic liquors pass off by the pulmonary exhalation; garlic and many other substances become sensible by the same means. Carbazotic acid and nitrate of silver dye the tissues, the former of a yellow, the latter of a purple colour. Dr. Graves has noticed a case in which sixty leeches, successively applied to a female who had lately taken hydrocyanic acid, all immediately perished; and Dr. Christison has related a similar case, occurring six hours after a dose of oxalic acid. Vernière poisoned an animal with nux vomica, and afterwards a second animal with the blood of the first. These examples afford the highest presumption that medicines actually enter the circulation before they produce their effects on the constitution; a conclusion which is further confirmed by observing that they equally produce their specific effects, whether administered by the mouth, applied to the skin, inhaled by the lungs, or injected into the veins. The following are demonstrative proofs of the correctness of this conclusion:

Iodine has been detected in the blood, saliva, sweat, urine, and milk; mercury, in the blood, crassamentum, saliva, and urine; lead, in the liver, spinal cord, and muscles; copper, in the liver and perspiration; camphor, sugar of lead, sal ammoniac, verdigris, and hydrocyanic acid, in the blood; sulphur, in the skin, &c. The authorities for these and many similar facts may be seen in Dr. Christison's admirable work "On Poisons."

That medicines should enter the circulation, and thereby produce their effects upon the constitution, is what we should expect; the extraordinary effects however, of certain poisonous substances excite our astonishment. Sir William Herschel has shown in regard to common matter that a power 50,000 times the power of gravity is generated by alloying mercury with $\frac{1}{1000000}$ th part of sodium. The same or greater effects follow the introduction into the blood of certain infinitesimal atoms of organic matters. Thus, the Woorara and Ticunas poisons; the poisons received in dissection of recently dead bodies; of hydrophobia, syphilis, and small-pox; of vipers and other venomous animals; and that proceeding from exhalations from the surface of the earth or from objects of disease, produce effects which, in reference to their causes, seem infinite. As we are not able to point out the distinguishing characters of these substances when they are presented to us in a concentrated state, it cannot be demanded that we should adduce direct proofs of their existence in the blood. Reason and analogy irresistibly conduct to this conclusion, as well as the fact that the blood, in most of these cases, is altered in its sensible qualities, is not disposed to coagulate after death, and speedily putrefies after extravasation. The following are additional impediments to the discovery of extraneous matters in the blood.

1st, The rapidity with which they pass off by the secretions; 2d, Their diffu-

ought to be exactly similar in all their dispositions and powers of action, or else the hereditary effect must be a mixture of both, either in equal proportions, or one side may preponderate more than the other. And this we find to be the case. A true and perfect hereditary cause is such as will produce its effects under all circumstances of life, not requiring the influence of any external circumstances whatever. It is hereditary for every animal to produce its own species, which may be reckoned the first hereditary principle. It is hereditary for every animal to produce the proper sexes, whether hermaphrodite or of distinct sexes. Of these distinct hereditary species we have varieties; and if the varieties, whether original or accidental, are such as can be communicated to the young, they are then hereditary qualities. Of this kind we may reckon shape, both of the whole body or of parts, the varieties of which come nearest to the original hereditary principle of shape. Size is a similar principle, as we see it is common for tall or short persons to have children of their own stature. Colour is another of these varieties, for we find this may become part of the principle of propagation, though not so permanent as some others. This property belongs to the epidermis, with all its appendages, as hair, nails, &c., which is subject to greater varieties perhaps than any other part: and those hereditary susceptibilities for certain dispositions and actions of the mind are perhaps as much hereditary as any other property in an animal.

These are what we may call permanent hereditary principles, becoming part of the constitution, and as subject to be produced in the offspring as any effect in nature. They are such as will take place under every external influence, as season, climate, &c. It is from these varieties being hereditary that we have a continuance of them from parent to child. When both parents

sion through 15 or 20 lbs. of blood; 3d, Their disposition to locate themselves in particular organs; and, 4th, Their actual chemical union with the elements of the blood. Mr. Hunter indeed doubted of the possibility of this latter circumstance taking place; but, not to mention the presumption which arises from other circumstances, the following experiment by Dr. Christison puts the matter beyond doubt. He injected eight grains and a half of oxalic acid into the veins of a dog, which was sufficient to kill the animal in 30 seconds; but although the blood was immediately tested after death, no traces of the oxalic acid could be discovered.

Whatever may be thought of these facts as proofs of the humoral doctrines, they plainly establish the fact that the blood is capable of considerable vitiations. In general, I believe, these vitiations ought to be regarded as effects, and not as causes, of disease. I conceive, however, in many cases the real cause of disease primarily exists in the blood, and is in that sense truly constitutional; and although we should regard these vitiations of the blood in other cases as merely *secondary* effects, yet we must admit that they will react on the original disease, and in this point of view be well deserving of the consideration of the practitioner. It is not unreasonable to expect that modern chemistry will throw considerable light on this subject, and discover some general principle by which the scattered facts which now exist relating to the blood will be connected and explained. In the present actual state of science these facts are *practically* useless.]

are constitutionally alike, they will produce children like one another, and also like themselves, though this is not absolutely certain, for a less marked hereditary principle may arise so as to produce children very unlike the parents. But if the disposition to produce similarity in the children to the parents be different in the two parents, it is impossible to say what the produce may be like.

Hereditary varieties will often last for some generations, and then become extinct, seeming, as it were, worn out. A large nose shall be continued in a family for several generations, and then cease. A peculiar gait, the turning in of one or both feet, shall in the same way continue hereditary for some generations; and it is very possible that if such children were to intermarry with one another, the hereditary disposition would never be lost.

There are latent hereditary dispositions, which pass over one or two generations, and start up again in the second or third.

Children are generally more like one another than like either parent, because they have the united principles of the parents, which are dissimilar, but united will produce the same results.

Parents may not be at all times disposed to form children alike. This difference seems to be owing in some degree to time between the births of the children; for we may observe that twins are more like each other than like those born a year or two apart, and these latter more alike than those born at the distance of several years.

If the varieties, as white, black, &c., are not original, they must be monstrosities; and then we may say that the disposition to produce monsters continues and becomes hereditary. The white negress, who may be called a monster of the black variety, being supposed to be born of black parents, and being herself white, with woolly hair, is a remarkable instance of the different dispositions of parents at different times. This woman married to a white man, and had three children, one quite black and the others tawny.

A gentleman had two children, both born with a disposition to exostosis; the son showed it earliest, and had exostosis on each thigh-bone, and indeed an increase of every bone in his body. The girl was little better off. Neither of the parents had any disease of the kind, but gave the disposition to their children by joint operations.

Of the acquired Hereditary Principle.—In these cases the principle is such as to require accident, or some external cause, to produce the disposition in such as have the susceptibility. In this case the susceptibility only is hereditary; but the disposition and action require the application of external influence before they will appear, and are therefore accidental. The action in this case is generally some disease.

As the susceptibility is in some degree hereditary, the immediate cause has been in some degree overlooked, and the disease has been called an hereditary disease; but it is impossible for a disease to be hereditary when one of its causes cannot be hereditary. It

may be hereditary for a man to be irritable, one man may be more readily put in a passion than another, but no man goes spontaneously into a passion, there must be some violence committed on the mind; and so various are our minds, that some shall be put into a violent passion at a circumstance which would only slightly or perhaps not at all, excite another.

The natural susceptibility for diseased action is so strong in some as to require only a slight secondary cause to put it into action; in others so weak, that it requires great violence as an immediate cause to bring on the effects.

All hereditary dispositions must be more prominent than those that are acquired or accidental; therefore people who have an hereditary susceptibility for any diseased mode of action will in general have it constantly, at least it will not vary so much as some others. It will not be of that kind which has a great tendency to disease at one time and not at another; such fluctuating dispositions cannot be hereditary.

Scrofula is one of those diseases which is supposed to be hereditary; but it is only the readiness to fall into this peculiar action, when properly irritated, that is hereditary: and when such a cause does not exist we find no scrofula.

Gout is another disease which is supposed to be hereditary, and there is often great reason in appearance for supposing that it is so. This is a diseased action which perhaps every one is susceptible of; but some fall into it much more readily than others, and this readiness may be hereditary. But this readiness never takes on action of itself; it must have the immediate cause to excite it, which is a stimulus of a particular kind. We find gout attacking people whose parents for many generations have not had it, and often never. We see it starting up in countries where luxury is introduced, where it was never known before. However, there are many instances where it would appear to be hereditary, as in the case of young men of fifteen, the sons of gouty men. But I suspect that this does not arise simply from the father's having had the gout, but from the circumstance that most people who have had the gout severely have deserved it, and that children have inherited the disposition for the way of living as well as the susceptibility for the disease, and will therefore be more liable to fall into the disease than children at large.

On this principle of the hereditary nature of diseases, if it be just, every disease under the sun will be hereditary: but many diseases having a stronger visible cause has made the hereditary susceptibility in them to be overlooked. Thus, the small-pox is as much hereditary as scrofula or gout, but from its arising in all cases from poison communicated, and evidently not in a spontaneous manner, is the reason why the hereditary susceptibility has been overlooked. But on our principle the small-pox is as hereditary as any other, only requiring the immediate cause to act to produce it as in any other disease. We may make the same

observation with regard to the venereal disease, for we see some persons much more susceptible of this disease than others are, and suffering more severely from it when they get it.

I do not know that we have an instance of observation which proves that the circumstance of a person's having had the disease renders him more liable to communicate that susceptibility to his offspring than if he had only the susceptibility for the disease, without the action having taken place. If it was a fact that the parents having simply had the disease, in some degree entitled their offspring to it, the human species would soon become extinct in those places where such diseases arose: and if the parents having had the disease increased the susceptibility in the offspring, both small-pox and lues would have become incurable by this time. So that the immediate cause, whatever this may have been, does not in consequence of its having had its full effect either give or even add to the disposition for such action.

The only difficulty I find, in stating this as a universal doctrine, is in the case of madness. This is allowed to be hereditary, and is I believe as much so as many, yet I cannot find the immediate cause in many cases. It would appear that the disposition to produce action is so strong as to go into action without the application of an exciting cause. It would be worth while to see whether people in a state of nature ever go mad: if they do not, then the state of mind in the civilized state is the immediate cause.

A gentleman informed me that he had paid particular attention to the diseases of Indians, and that he never heard of an Indian going mad.

On the Effects of Mind on Diseases.—When on the animal economy, I observed that the mind was formed by the senses, as also the will; that the will produced the voluntary actions, but that the mind produced actions both of the voluntary and involuntary parts, which actions are often very irregular and undetermined. On the state of the mind, therefore, the latter will depend, or at least they will change with it, and even the former may be affected by it; indeed there is not a natural action in the body, whether involuntary or voluntary, that may not be influenced by the peculiar state of the mind at the time, and every particular mode of the mind has some parts that are more readily influenced by it than others. The skin is affected by the feeling of shame; the secretion or even the non-secretion of the testicles takes place under certain states of the mind. Palpitations of the heart and quick respirations are brought on by some states; purging and increased secretions of the urine by others.

In voluntary parts we can also perceive the influence of the mind. It often produces actions independently of the will, especially when these actions are begun by the will, and when the mind is affected by a recollection of them; or even contrary to the will. Thus, fear produces a vibratory contraction of all the voluntary muscles, while the will is doing all it can to stop it. Since the mind has such

power over the natural actions of the body, we might suppose it would have considerable effect in disease ; and this we actually find it has, especially in those who have a strong susceptibility for such actions as the mind can most easily affect. We should naturally expect that it would be [diseases principally connected with the nerves that the mind would most affect, though we do find that there are other diseases, with which they appear to have little connexion, that are much affected by the state of the mind ; and I believe that it is principally those diseases in which the alteration is in the action of parts, not in their structure.

Minds which are particularly irritable are most subject to such diseases, having the acting parts more under the control of the mind, and less under that of the will ; also the involuntary powers are more under the influence of the state of mind, as the heart, &c. These diseases are called nervous, and more peculiarly belong to women, who being less acquainted with the real properties of natural things, are more apt to imagine preternatural ones ; and their reasoning powers not being so strong, they indulge the actions of the mind more, and allow it to take possession of the body ; for the mind can often prevent diseases of such a nature as are contrary to health, and depend on voluntary actions, of which take the following instance. A woman, aged forty-six, of a good-natured disposition, had been troubled for some years with a drawing of the neck to one side, by the contraction of one of the mastoid muscles : this it was always in her power to prevent, by contracting the opposite muscle, when she sufficiently recollected herself. The right muscle, the one affected, did not contract of itself, unless by some accident she of her own accord contracted it a little, after which it continued contracting till it produced its full effect. When her mind was agreeably engaged she seldom felt it, or when conversing with an intimate friend or reading ; but fear and every other unpleasant state always produced it. If she expected to see any stranger before whom she was particularly anxious to hide her defect, she had it always more violently than usual. This circumstance of the mind's continuing action when it has once taken it up, is remarkable in hiccup, which is often produced by laughing ; thus hiccuping, which is an involuntary action, is produced by laughing, which is a voluntary one. But as the state of the mind is thus capable of producing a disease, another state of it may effect a cure : so the hiccup may be cured by producing fear. There are other diseases which a state of the mind may cure, though they have not been brought on by it, as agues have been cured by charms which have been used with a thorough conviction of their being a sovereign remedy. I am apt to suppose that a spider's web, when taken for an ague, cures in the same way, at least in one case ; for on giving it without the patient's knowledge, it had not the slightest effect ; but by persuading the patient that it was a spider, the effect was produced, at least the disease did not return. Even tumours have yielded to the stroke of a dead man's hand.

It often happens that there is a suspension of some actions in an animal body, and those actions return again. Thus we have epilepsy, which is a suspension of the sensitive principle's actions: sometimes we have suspension of the heart's actions. It is perhaps impossible to know the cause of these suspensions, and equally so the cause of their return. I am apt to suspect that suspension of natural action becomes the stimulus to the powers to put themselves in action again; or, in other words, the suspension becomes by its continuance a force imposed on parts to act, and they act to relieve themselves. Thus, by stopping respiration we have such a stimulus raised in consequence that we can no longer live without the action, and the action takes place.

I suspect that opium often produces a struggle between the necessity of action and the consciousness of the preternatural suspension, which rather rouses. Death, which is the ultimate suspension of all actions, seems to explain that, as a person seldom dies without a struggle or convulsion. Convulsion appears to me to be an action arising from a consciousness of debility; as if there was an endeavour to act to preserve life, but not being able to preserve it, they give up the contest.

Of Symptoms.—A symptom is a sensible effect of a diseased action. The first mode of sensation is when the disease is shown directly, without the medium of any other reference, and is known only to the patient; of this kind is pain. The second is where it is given by a reference to some other sense, as that of touch, smell, &c., and is common to the patient and others; of this kind is the swelling of tumours, the redness of inflammation, &c. The third arises from a deficiency of sensation, and can be known only to the patient himself. It is by description and the second set of symptoms that the practitioner receives his information. Local disease may produce only the first mode of intelligence, as pain; or it may proceed to the second, as inflammation; or the second may be produced without the first, as indolent tumour, not known till felt by the hand.

Pain is a simple sensation which is common to many diseases, and is divided into several kinds, as sharp, sore, numbing, heavy, &c. The sharp pain is that produced by cutting with a knife; the sore, from inflammation and ulcers; the heavy, that which takes place in rheumatism; the numbing, from pressure on a nerve. The sharp and sore depend on what I shall call vibration of pain, particularly the latter. The heavy seems to be a continual pain, or where the repetitions are so quick as to appear continued; but probably all of them are owing to a succession of actions of the nerves. We refer all the sensations we can to those senses which give us the greatest intelligence. We call them sharp pains from their giving the sensations of any thing that bites, or stings, as bees, or acids on the tongue; heavy, from their giving us the sensation of bearing a weight on the part. A gentleman who had a hemiplegia, said his sensation

was similar to an acid on the part, that is, to that feeling on the tongue.

We have often a bad taste in the mouth, or a bad smell; this is not always a sign that the saliva or mucus is altered in its qualities, as it is in salivation from mercury, which appears to be from the taste and smell of the mercury, but it is sometimes produced by a morbid action of the nerves. We have these symptoms, together with ringing in the ears, commonly in the beginning of diseases, and probably they arise from the actions of the disease in the nerves of the part.

Neither susceptibility nor disposition for diseased action can produce a symptom; it must be preceded by action; though I believe that there will sometimes be an unnatural feel in a part before action has taken place, as before a fit of the gout attacking the foot an indescribable sensation is sometimes felt, and when the action takes place the constitution is relieved.

Symptoms are either local or universal. Local, as chancre, cancer, &c.; universal, when they accompany universal diseases, as fever. Local symptoms may produce universal ones, which is a means either of increasing the local symptoms or of curing the disease. Local symptoms will vary according to the nature of the disease; its violence or its situation, as inflammation, will produce different sensations in different parts. Universal diseases will produce some of the following symptoms: affection of the pulse, which arises from the heart's sympathizing and partaking of the disease; the alterations are very various, as full, strong, weak, small, &c. The secretions are altered, as in fever; the tongue becomes covered with its own secretion, at first white, afterwards brown, or sometimes black, which last colour arises from blood being mixed with the secretion. The tongue also contracts in size, and we have often thirst without its being dry, and sometimes, as in low fevers, very dry without thirst, which last is owing to a diminution of sensation in the nerves, and is an unfavourable symptom. The urine is high-coloured, without sediment, owing to its being retained long in the bladder, from debility of that organ or from blood being mixed with it. The respiration fails, from debility in the lungs. The heat of the skin is altered from too great or too little action of the vessels: The colour of the skin in some diseases changes, as from white to yellow in a very short space of time, not from jaundice, the white of the eye not being changed; nor could jaundice be so quick in coming and disappearing; it is probably a change in the rete mucosum of the skin, such as takes place in the chameleon and some other lizards; veins of the skin are enlarged by any tumour seated beneath them; as in hydrocephalus, tumours of the breast or of the uterus during gestation, the veins of the head, chest, or belly will be found enlarged.

The feeling of the part is the first mode of intelligence. Suppose a stone in the kidney; it may produce three symptoms: 1st, Pain in the part; 2d, Vomiting, which is symptomatic; 3d, Bloody

urine. Now these symptoms may occur in other diseases, independently of stone; if they are combined, they afford a pretty certain diagnosis of the presence of stone, but any one or two of them leaves it doubtful. These symptoms attend the passing of a stone through the ureter, as well as when in the kidney; and when a stone gets from the ureter into the bladder the symptoms abate, and a different pain is felt, and this change occurring confirms us in the opinion we had before formed of the existence of a stone.

Anomalous Symptoms.—These are not immediately expressive of the disease, but make the diagnosis doubtful. They are very numerous, taking in all the symptoms which occur from dentition, worms, &c. Many of them are from sympathy, which we mentioned before.

Delusive Symptoms respecting Sensation.—This delusion of the senses makes disease seem where it really is not, from the different seat of the symptoms and of the diseased part. Thus, diseases of the liver are referred to the shoulder, of the testicles to the back, of the hip to the knee, and even in some cases, as was before observed, they are referred to some other person. When the trunk of the nerve is injured, the pain is referred to the termination of it, as, after amputation of the leg, pain is felt in the toes. When pressure is made on a large nerve, the most acute sensation will be at some distance below the part pressed on.

A gentleman complained of a pain in the hip, running down the outside of the leg and foot. Supposing it rheumatism I gave him James's powder, Dover's powder, and volatile tincture of guaiacum, but with no good effect. A liniment of opium to the leg and foot gave some relief. He at last perceived a tumour by the os ischii, just at the posterior edge of the gluteus maximus. This tumour increased, and the person died. The tumour was found to fill a part of the pelvis, and had made its external appearance at the foramen magnum ischii, being filled with coagulated blood; but the pain in the limb seemed to have been produced by its pressing on a great branch of the nerve, but chiefly perhaps from the great ischiatic nerve being stretched very tight over the upper surface of the tumour. Here that happened which may often be observed; that is, the impression made on the trunk of the nerve gave a sensation as if it had been on the extremities of the nerve. The first action of a nerve is at its extremity, and the last in the brain; and this last in the brain refers the sensation receiving the first impression; and if, after the brain has become accustomed to refer any sensation to the extremities of the nerves, any impression be made on the trunk, the brain receives the impression in the same point where it was accustomed to receive the impressions made on the extremity of that nerve, and therefore the mind refers the sensation to the same spot, that is, the extremity of the nerve. This happens when the part to which the sensation is referred does not exist, as

a person, having had an amputated limb, will for a long time refer his sensations to the fingers or toes.

In diseases the general character of the patient should be known, which is essentially necessary before we can judge of every symptom; for besides what we can know by the symptoms of a disease, yet peculiarity of temperament, &c., will occasion great differences in the character of the disease. For our being informed by the first mode of intelligence, the patient's sensations, the patient must be in his right senses, otherwise he may be deluded, and delude us. But even where the patient is perfectly sensible, many symptoms may appear to the physician which the patient is not sensible of, as wild looks, quick pulse, &c. The brain may not be conscious of them, and a false conception of their feelings is then present; and this may be called half-delirium. A complete delirium is an action of the mind directed by no sensation whatever. But we do not know how to distinguish between these two deliriums, the former being an action of the mind from sensation, but which sensation is incapable of directing its influence to the senses, and refers it to other parts or other objects. These should be well understood in practice, as in half-delirium the patient will have the sensation, but will direct it to some one else, or to the wrong part, which if we know we may be able to afford them the relief they want. The history of every thing relative to a disease should be known, as symptoms alone are often not enough to direct us; we should, therefore, get the history of it and of prior diseases, of peculiarity of constitution, manner of living, &c.

CHAPTER XII.

GENERAL PRINCIPLES OF INFLAMMATION.

Frequency of inflammation;—nature of;—enlargement of vessels;—several species;—simple or compound;—three results from inflammation in a healthy constitution:—adhesion,—suppuration,—ulceration.—Adhesion;—nature of the uniting medium;—partakes of the quality of the diseased solids;—its uses.—Suppuration;—differs in degree according to the exciting cause.—Ulceration;—its uses.—Exciting causes of inflammation;—accidental or specific.—Remote causes of inflammation.—Comparative susceptibility of parts to inflammation.—Effects of inflammation on the constitution.—Of the pulse;—varies with the states of the constitution;—varieties of pulse;—causes of the varieties.—Effects on the constitution according to the state of the inflammation;—rigors.—State of the blood in inflammation; colour, heat, coldness, pain of the inflamed parts.—Declension of inflammation.—Ecchymosis;—varieties of;—termination of.

THE operation in the body called inflammation is one of the most common and most extensive in its effects, and requires our greatest

attention. It is the cause of many effects, both salutary and diseased, producing abscesses, fistulas, diseased bones, &c., and in many diseases is the first step towards a cure; so that it becomes a first principle in surgery.

Inflammation would appear to be produced by an *increased action* of the vessels, but it is most probably in the smallest vessels, for it may be confined almost to a point where none but the smallest vessels exist. What the particular action is, or in what it differs from the common action of vessels, is not easily ascertained, we being more able to judge of the effects than of the immediate cause.

Inflammation may be considered as a genus, of which there are many species. It may be divided into healthy and unhealthy. The healthy is that which will always take place in a healthy constitution or part, and is rather to be considered as a restorative process than a disease. Unhealthy inflammation is that which takes place in an unhealthy constitution or part, and will vary according to the kind of unhealthiness of that constitution or part.

Inflammation is either simple or compound; simple, when there is only one mode of action in the part inflamed, as in the first stage; compound, when there are two or more modes of action. The compound produces three great effects, namely, adhesion, suppuration, and ulceration, which I shall call adhesive, suppurative, and ulcerative inflammation. The last is only an effect of inflammation, for the process takes place in a different set of vessels.

I shall place the adhesive first in order, though it is not always so, for with respect to priority of these effects of inflammation, it depends principally on the nature of the parts, with the degree of violence of the inflammation. To explain this more fully, I shall consider inflammation as it affects, 1st, The cellular membrane in general, and the circumscribed cavities; 2d, All the outlets of the body, *i. e.*, the excretory outlets and ducts of glands, as the mouth, nose, tunica conjunctiva, &c., which have been called mucous membranes, and which I shall treat of in their proper order.

When inflammation takes place in the first order of parts, it is commonly the adhesive: but it will be according to circumstances whether the suppurative or ulcerative follows first, and probably according to the degree of inflammation. But it sometimes happens that the suppurative takes place almost immediately, probably from two causes, either from the inflammation exciting the suppurative almost immediately after the adhesive, or from the inflammation having little or nothing of the adhesive in it. I suspect that the erysipelatous has little of the adhesive in its nature, no adhesion taking place before suppuration, whilst in phlegmonous inflammation of the cellular membrane it does; so that the erysipelatous might be called œdematous inflammation. When inflammation occurs with violence on the surface of the skin, the ulcerative process takes precedence of the suppurative, although in the cellular membrane the reverse of this is the case. In the second order of

parts the suppurative takes place first, and the adhesive does not take place, unless the inflammation is carried to a great height.

When the inflammation is in the first order of parts, the suppuration and ulceration are so many actions superadded to the first, or adhesive, and arising out of the effects produced by that which now become new causes, especially of the ulcerative, which is an action of the absorbents. All these actions arise from the first irritation or cause.

The adhesive or suppurative, either in the first or second order of parts with their varieties, may have a fourth character superadded, such, for example, as the scrofulous or venereal disposition, or other specific disease.

These three modes of action, when carried on perfectly, are the effects of a good constitution, and constitute what I would be understood to mean by common inflammation.

The union of cavities in an animal body is formed by a uniting medium, which appears to be the coagulable lymph, which, by the inflammatory disposition of the vessels, is separated from other parts of the blood and thrown out on these surfaces. That this is the case appears from the following observations. In all large cavities where we can make our observations with certainty, we find when they have been inflamed that a substance similar to the coagulable lymph when separated from the serum and red particles, is diffused all over the sides or through the cavity. When we cut into an inflamed part after death, we find it firm and solid, like the section of a lemon, or some œdematous tumour, where we know extravasation has taken place; and this appearance arises from the cells of the cellular membrane being loaded with extravasated coagulable lymph.

This mode of separation of coagulable lymph is not peculiar to this species of inflammation; it is separated on many other occasions to form tumours,* where inflammation does not seem to be the leading cause.

It is probable that the coagulable lymph undergoes some change in its passage through the inflamed vessels which obliges it to

* [As we are not acquainted with the mode in which the process of nutrition is accomplished in its natural state, it is not to be expected that we should be able to account for those aberrations from the healthy state which constitute tumours. If the formation of tumours depended upon the organization of effused blood or lymph, we should expect to see them much more frequently than we do, since few persons escape effusions at one time or other; and we should likewise expect to see them differ in their incipient and in their advanced stages. Observation, however, discloses nothing of this kind; on the contrary, the peculiar structure of tumours is as well characterized at first as when they become more fully developed: the blood or lymph which is effused in inflammation or by accident is generally absorbed, and in the great majority of tumours we are unable to refer to any previous injury or inflammation to account for their origin. See Home (*Trans. of a Soc. for the Imp. of Med. and Chir. Knowledge*, vol. i.), and Abernethy (*Works*, vol. ii.), who have advocated the opinion in the text, and Lawrence (*Med.-Chir. Trans.*, vol. xvii.), who justly, in my opinion, objects to the statements of these gentlemen.]

coagulate sooner than it otherwise would, for in those cases of inflamed arms, after bleeding, we find that the cavities of the veins are in many places furred over, and in others united by coagulable lymph, which must have been thrown out by the vasa vasorum, and coagulated blood immediately. Hence it is reasonable to suppose that in this separation the lymph must have undergone some change, arising from the vessels, and that it is not simply such coagulable lymph as is circulating in the blood, else it would be carried off by the circulating blood passing through the vein. This change I suppose to arise from sympathy with the inflamed vein. The lymph seems, however, to retain the living principle, and probably in a greater degree than under common circumstances, and is, therefore, better fitted to become a living solid. It does not seem, however, absolutely necessary that coagulable lymph should first undergo this change in the extravasating vessels, for, as I have before said, blood extravasated from ruptured vessels is perhaps equally efficacious in this respect.*

It does not seem necessary for both surfaces that are to be united to be in a state of inflammation, but only for one, to throw out the coagulable lymph; nor indeed does inflammation of either seem necessary, for union by extravasated blood may take place without inflammation.

Extravasated coagulable lymph, which produces either adhesion or tumours, always partakes of the nature of the diseased solids that produced it; if the case is venereal, the new substance is of the same nature; if cancerous, cancerous; for the absorption of this effusion from a cancerous breast will produce cancerous axillary glands.

The intention of the adhesive inflammation is in some degree to set bounds to or prevent the necessity of its own larger extent. In large cavities the inflamed parts adhere, and thereby exclude or prevent the other parts from the necessity of falling into the same irritation. But the chief intention is to confine the suppuration to those parts where it takes place, for where the adhesions are perfectly formed the operations of inflammation appear to be completed, so that the suppurative process does not spread; it also serves to confine the matter to the cavities where it is formed.

Inflammation often goes no further than adhesion, and then subsides and goes off, which is termed resolution. This cannot take place in all inflammations, but only in those where the parts can be brought into contact, for if the part in which it takes place is an open cavity, suppuration will take place.

When the adhesive inflammation is not capable of resolution, suppuration takes place. The immediate effect of this process is the production of matter from the inflamed surface, which appears under such circumstances to be a leading step to the formation of a new substance, called granulations, which granulations are the

* [See note, p. 34, and Treatise on Inflammation, Part II. Chap. I.]

second method of restoring the first order of parts to health. But on all internal canals suppuration does not necessarily lead to granulation.

In order for spontaneous inflammations to produce suppuration, they must be much more violent than those inflammations (suppuration being equally necessary), arising in consequence of an operation or accident: and those inflammations from either operations or accidents, if they have not produced death in the part operated on, are more violent and of greater extent than those in which death of a part has been produced. Thus, the inflammation of a boil or bubo is more violent and commonly more extensive, than that in consequence of a cut, or even amputation of the leg; and the inflammation arising from these latter will be more violent than that from a gunshot wound on the application of caustic. It may not be easy to account for all these differences; however, it is possible that in spontaneous inflammations the inflammation is more necessary for the ultimate effect than the suppuration; as in gout, the inflammation is the mode of carrying off the action of the disease. It is curious to remark, that in gout nature seems to produce all the purposes and effects intended by inflammation, but unaccompanied by either adhesion, suppuration, or ulceration; and although the inflammation runs much higher here than in many other cases, and although it is attended with all the common appearances, yet no adhesions are formed here: for the lymph is taken up, and chalk (urate of soda) is deposited in its place. In spontaneous inflammation, parts are either naturally more susceptible of the inflammation, or become so by disease. When inflammation is produced by stimulus of the death of a part, or of effused blood, the inflammation is commonly slow; but that from a bruise is often quick and violent, but then the injury has not produced death. If caustics do not act with vigour, they will irritate and inflame much sooner than if they had immediately killed the part; but irritating applications must be continued some time to produce inflammation. After operations where inflammation must take place for the union of the wounds, suppuration is more necessary than inflammation, and we find it is soon produced.

The ulcerative inflammation is that which takes place in consequence of suppuration, therefore is not so much the original inflammation as the consequence. It is that inflammation which disposes parts to absorb themselves, and which brings matter or any extraneous substance to the surface to be discharged, the absorbents removing all the parts lying between the matter and the surface. This process has been erroneously ascribed to the melting down or dissolution of living solids with the pus.

From the foregoing general account of inflammation, it may be said to arise in all cases from injury done to the solids, where either the natural conformation of parts on which natural actions depend is so destroyed that they are not able to support themselves in that state, or from the natural actions or functions of a part being materially

obstructed, the texture not being primarily affected. The first state arises from causes that are visible or external, such as the application of any irritating matter, as a blister, heat, or even cold, which acts as a sedative when applied only in a certain quantity ; but when in too great a quantity, the parts, finding that they are losing their action, are roused to action beyond that which is natural, in order to destroy the irritating cause. Inflammation may also be produced by causes not known or suspected, or from a constitutional disposition being determined to some part, producing local effects. I need hardly mention that fever is thus often a cause of local inflammation.

Inflammations from the constitution are of two kinds : one may be called accidental, as those arising in common fever ; the other are determinate, depending on the species of fever which may be called specific, as small-pox, &c.

These inflammations are thought to be critical, but I very much doubt the truth of this opinion. The small-pox and chicken-pox are the only diseases that can be brought in proof of it, with perhaps the inflammation of measles ; but even these pustules or abscesses are, perhaps, not necessary, as critical abscesses, to carry off the fever, for specific fevers cannot exist beyond a certain time, though no eruption appears ; which time depends on the nature of the poison, and the constitution. And in these diseases we have large abscesses as often formed as after any other ; and certainly I cannot suppose those abscesses to be critical, for they possess nothing of the specific nature of the preceding disease, and must therefore be common ; or, where the constitution possesses a susceptibility for scrofula, they may be scrofulous, but not critical ; and as the preceding disease has already been followed by pustules or abscesses which, if any deserve to be termed so, certainly ought to be termed critical, we shall find that these inflammations and abscesses depend on the state of the constitution and part at that time, and are an effect of simple fever abstracted from every specific peculiarity. Fever is at all times a disturbed action, which may have a specific action joined with it or not. The inflammatory fever is perhaps, the most simple fever ; and the putrid fever is, perhaps, only the same fever occurring in a constitution predisposed to its peculiar actions. This opinion may be illustrated by what occurs in the small-pox ; two different people having this fever from the same infection, the effect in one will be benign small-pox, with only simple inflammatory fever ; in the other it will be erysipelatous or confluent small-pox, with a tendency to putridity or gangrene. This difference cannot depend on the specific poison, as this can have but one mode of irritating. Now, since every fever is capable of producing inflammation and abscess, and as I have shown that in specific diseases they have no right to be termed critical, they certainly cannot be supposed critical in common fever.

Inflammation may arise from one of four causes, which may be called remote : 1st, From accidental force applied to a part : 2d, From some irritation, which does not destroy the texture of a part, but simply the natural actions, as friction, blisters, heat, cold, and

often fevers of various kinds ; 3d, From some particular disposition in the part itself, as boils arising spontaneously ; 4th, From the general state of the constitution affecting some particular part, as gout falling on the toe, or the irritation of fever on the lungs, liver, or any other part, producing adhesions or abscesses ; but such, I suspect, are of the scrofulous kind, and not in the least critical, and therefore belonging to the second cause. To these, I think, we may add specific causes, as scrofulous, venereal, &c., as a 5th ; and the stimulus of defect or imperfection of parts, especially cavities, as a 6th.

Obstruction of the blood's motion in the small vessels has been long supposed to be a great cause of inflammation, but is, I believe, now pretty generally rejected. This was certainly too confined an idea : it reduced all inflammations to one species. The only distinctions of inflammations must then have arisen from the nature of the constitution ; but this doctrine never could account for the peculiar action of any specific disease or poison. It was also too mechanical. If they had said that any obstruction to the natural actions of the parts which could stop the blood's motion in the part became the cause of inflammation, they would not have been so much out as to a possible cause of inflammation. In such a case the stagnated blood would cause irritation of the vessels, and suppuration would be produced to get rid of it. The immediate operation of these inflammations cannot be called disease, though their remote causes may, as small-pox, &c. ; for they may arise from the part being only disturbed, and hardly exceeding the idea we have annexed to that of being disturbed. It is the cause producing inflammation, then, which is the disease and not the inflammation,* for all inflammations that can be called diseases have specific causes ; and, indeed, even these can be hardly called diseases, for in small-pox, where the inflammation goes on well, it is merely the action of health ; if diseased, it would be erysipelatous, &c. Sometimes, by amputating a leg, more than simple disturbed action is produced, for it is a great loss to the constitution ; but yet when the constitution is in a healthy state, we generally find a healthy inflammation and digestion of the wound take place : it will not go into an inflammation which is unhealthy. Specific inflammation as well as simple inflammation partake of the nature of the constitution. Some constitutions are more disposed to certain specific actions than others, and will fall into that specific kind of inflammation, as the erysipelatous, the

* [That is, inflammation with a specific character is the only inflammation which can be denominated disease. The meaning of the author I conceive to be simply that pure inflammation is a restorative action, in contradistinction to the actions of disease which tend to destroy (pp. 15, 97) ; and to this general statement there can be no objection, although it must be borne in mind that the rule of judging from final causes cannot be applied absolutely without excluding from the list of diseases a great many affections to which it would be absurd to deny this title, such as sickness, purging, increased secretions, ulceration, mortification, &c., the tendency of which on many occasions evidently is salutary, or to get rid of some noxious matters : still there is sufficient ground I think for the general observation.]

scrofulous, &c.; and every aggravation is an aggravation of the specific nature of the inflammation; thus it happens in scrofula, cancer, &c. But some specific irritations bring all constitutions, to their own nature, as the plague, jail-fever, &c. Here it is not a specific joined with a simple inflammation, but a thorough change of constitution, and the patients generally die, all suffering alike. The inflammation arising from these causes may be either the adhesive or the suppurative. From all which we may conclude that irritations either produce inflammation according to the disposition of the constitution or of their own nature, of which last is the plague.

The specific diseases will change, according as the constitution changes; for instance, after receiving the small-pox, if the constitution, then healthy, should by any means become disposed to show putrid symptoms, the small-pox will have the same appearance; but if the constitution is altered from this tendency, the eruption will also alter. Now the knowledge of this fact is very useful in the treatment of specific diseases; for example, if with a venereal chancre the constitution be erysipelatous, we may have an erysipelatous inflammation in addition to the chancre, which will spread over the whole penis. Now, in this case, we must make use of mercury against the one, and of bark against the other of these specific diseases, until we bring it to the simple ulcerative inflammation. Again in the small-pox, when simple, the pustules retain their specific distances, but if an erysipelatous inflammation be joined to it, it becomes of the confluent kind. In the irritable constitution we find from continuous sympathy the inflammation will extend itself very far; but in general we find that considerable inflammations confine themselves very much.

Some parts are more susceptible of one kind of inflammation than of others; some admitting only of one kind, some two, and some all three, which difference appears to be according to the situation in the body of the inflamed parts, and also according to the nature of the parts inflamed. The deeper-seated parts, especially the vital, admit very readily of the adhesive inflammation, as is proved by dissections, for we hardly ever open a human subject that has not had considerable adhesions in the circumscribed cavities; but they do not so readily pass into the suppurative, which is fortunate, otherwise internal inflammation would oftener kill. But if the inflammation comes on at once with great violence, it would appear to pass almost at once over the adhesive, and to take up the suppurative action, and in this case we may sometimes have the erysipelatous added.

The external parts of the body are more susceptible of the suppurative inflammation than the internal, but they always begin with the adhesive. This greater susceptibility of the superficial parts to suppuration is shown in the passage of pins, bullets, and other extraneous bodies to the surface: if deep-seated, they will remain a long time inactive, inclosed in a cyst, and produce no inconvenience until they work their way to the skin, when suppuration will

be produced. It is very remarkable of the cattle which feed in the bleaching-fields, and are always found after death to have a number of pins in them. (The stomach of a bull was shown, in which several pins were sticking, and which were not known to have caused any inconvenience.) Perhaps this does not altogether depend on the situation of the part, but also, on the degree of irritating power possessed by the extraneous substance: thus, metals and glass seem to produce such a disposition in the part, that it becomes satisfied with the adhesive inflammation. A gentleman had a piece of glass in his hand for many weeks, which produced no pain, except on pressure. This insensibility of deep-seated parts to extraneous substances, depends on a sac being formed around these substances, possessing a peculiar degree of insensibility. Nature acts here with her usual care, preferring the least evil by securing the extraneous substance in a part possessing peculiar insensibility, rather than calling up the vital powers to produce suppuration, which must be considerable to reach the surface, and might expose parts which would be attended with considerable danger; but when they become external, then she chooses the other, to get rid of them as soon as possible.

In my division of parts, as regards inflammation, into two orders, I have made a distinction between the cellular membrane and circumscribed cavities on the one hand, and the ducts, canals, and outlets which are lined with what has been called a mucous membrane on the other. In the first order of parts, inflammation proceeds in this order; adhesive, suppurative, ulcerative; but in the second order of parts, the order of inflammation seems to be inverted as regards the two first, as may be seen in internal canals. In these, if the inflammation is but slight, the suppurative takes place almost immediately, not being retarded by the adhesive going before; as we see in gonorrhœa, catarrh, &c. It has been said that these discharges are not purulent, but in my opinion they certainly are; the purulent matter being only a change in the natural secretion, and its thickness or thinness depending on the degree of the inflammation. If the erysipelatous inflammation should come on in these parts, then the movement takes place from the suppurative to the ulcerative. In the mucous membrane ulceration will take place, probably from the violence of the inflammation having produced coagulable lymph, which acts as a stimulus, and the parts having been weakened, are unable to support themselves: this is sometimes the case in the mouth, from salivation; in the tongue, &c., in scurvy; in the intestines, in dysentery, &c. Mr. Hunter endeavoured to produce adhesive inflammation in the vagina of an ass. He first, by moderate stimulus, could only produce suppuration, but by a very active stimulus, as a solution of corrosive sublimate, he produced the adhesive, causing coagulable lymph to be effused, which afterwards became membranous and inseparable, as was seen in the preparation of the parts which he exhibited.

Strength and weakness of the constitution, or of the part affected,

will produce very different effects in inflammation. Strength produces good effects, and renders the disease more manageable, for it lessens irritability. Inflammation is most manageable in parts in the following order: muscles, cellular membrane, and skin, and the more so the nearer the source of circulation. In other parts, as bones, cartilages, ligaments, &c., which have but little power in themselves, it is less manageable, though the constitution be good, for the constitution feels conscious of the weakness of these parts, by which affection of the constitution they become further weakened. In vital parts, inflammation also is very unmanageable, though these have power in themselves; but in consequence of their being affected, the universal health is destroyed, and hence the disease is less manageable. If the stomach is inflamed, no operation of the body can go on well, the powers of restoration becoming weaker than ever; hence the greatest danger is to be apprehended.

Strength of the constitution and parts affected, when under inflammation, produces the following effects: viz., a more ready and quick termination, whatever it be. Thus, a wound in a healthy constitution unites more readily by the first intention; adhesive inflammation more readily terminates by resolution. If inflammation have got beyond the first stage, it passes sooner on to the suppurative inflammation; nature going through her operations with greater facility and despatch in such a state of constitution.

Weakness of the Constitution and Parts.—When a wound is made in a person of a weak habit, the union is more difficult, and the inflammation is more likely to continue; and this not from there being a greater disposition to inflammation, but from want of a power and disposition to heal, nature needing greater and longer exertions to produce the intended effect.

In this state of the constitution and parts we often find that parts seem hardly capable of taking on either adhesive or suppurative inflammation: and in some of these habits inflammation will hardly even follow a solution of continuity. As in dropsy, I have observed that the puncture made by tapping or scarifications will hardly heal; a degree of inflammation does take place, but not sufficient to procure a healing of the wounds or suppuration, but mortification soon comes on. If in such a constitution a wound is made, the blood not coagulating sufficiently to heal it by the first intention, dies, and becomes an extraneous substance, causing irritation: suppurative inflammation succeeds, and often mortification, which mostly proves fatal.

Effects of Inflammation on the Constitution.—The sympathy of the constitution upon an act of violence to the parts, is probably the most simple act of a constitution. But this will vary in different constitutions, because all constitutions do not sympathize equally. It will vary according to the stage of the inflammation, and according to the disposition of the parts inflamed.

We find the effects of inflammation on the constitution as various

as any other circumstances, which appear to arise from the following causes ; first, from the nature of the constitution ; secondly, from the nature of the inflammation, whether common or specific ; if common, according to the stage of the inflammation, whether adhesive, suppurative, or ulcerative ; if specific, according to the kind, although I believe specific irritations do not produce much variety in the constitution, except the plague, which entirely changes it, and such as by their long continuance weaken the constitution, as lues, when of long standing ; but this will be similar to any lasting disease, for at first it certainly does not affect the constitution so as to alter the disposition of a wound made on any part : thirdly, from the nature of the part inflamed, whether vital or otherwise : and, fourthly, from the different situation of similar parts, as of the muscles or cellular membrane in the legs or arms, &c.

In inflammation we have seldom more than the continuous or the universal sympathy, but sometimes the remote. The continuous causes the inflammation to spread. The general is when the constitution becomes affected. The remote is seen in pain of the shoulder, from inflammation of the liver.

As the effects which inflammation has on the constitution are by sympathy, they will be in proportion to the readiness it has to go into that action ; and this is much greater in some constitutions than in others ; moreover, every constitution sympathizes more readily with some parts than others. The kind of constitution least affected is generally the most healthy where sympathy hardly takes place, the surrounding parts even seeming hardly to feel what is going on in those nearest them.

The nature of the inflammation produces, I believe, but little variation in these effects : for, of whatever kind, the sympathy will be in proportion to the violence of the inflammation, and its rapidity. Hence as the inflammation which produces healthy suppuration is more rapid, it generally produces more violent effects on the constitution than any other.

The effects which inflammation has on the vascular system, and which are chiefly discoverable by the pulse, are very remarkable. In considering the peculiarities of the pulse, it is always necessary to remark that there are two powers acting to produce it, viz., the heart and the arteries. That one part of the pulse belongs to the heart, another to the arteries, and a third is a compound of both. The stroke, which is the pulse, (as regards the number of strokes in a given time, the regularity or irregularity as to time, and the quickness of these strokes,) belongs to the heart. The vibratory pulse and slowness of the systole, with the fulness and smallness of the pulse, belong to the arteries.

As the pulse arises from the actions of the solids on the machine, it is of course according to the nature of the machine at the time ; therefore is capable of being in one of two states, natural or diseased.

In most diseases of the constitution, whether original or arising

in consequence of diseases of parts in which the constitution becomes affected by sympathy, the pulse is altered from the natural to the diseased state which is according to those affections.

The varieties of which the pulse admits are numerous. It may be increased or diminished in the number of strokes: regular or irregular as to time; quick in its stroke, or diastole, and slow in its systole; or it may be hard in its diastole. In all cases probably, when the constitution is in a state of irritation, the pulse will be quick and frequent in its number of strokes in a given time, and the artery being hard, from the constant contraction of its muscular coats, will give a feeling of hardness to the touch: besides which the diastole of the artery is not uniformly and regularly the same, but there are a vast number of stops or intermissions, which are so quick as to give the feeling of vibration, or what we call thrill. In such a disposition the pulse may be either full or small. These two opposite effects do not seem to arise from the difference in the quantity of blood, as might at first be supposed; but arise, I rather suspect, from the difference in the degree of strength and quantity of irritability that the patient possesses at the time, which when joined, give an antidiastolic disposition to the arteries, so that when the arteries have a full power of contraction and are in a state of irritation at the same time this effect will always take place.

It is certain that arteries in such a state of constitution do not dilate so fully and freely as at other times; and as this varies quickly as the state of the constitution varies quickly, it is more reasonable to suppose that the effect is immediately from the arteries than from an increase or decrease in the quantity of blood. If this is really the case, we should naturally suppose that the motion of the blood in the arteries would be increased in proportion to their diminished size, unless we should also suppose that the systole of the heart should be diminished in the same proportion, which I think is probably the case, as we find the blood forsakes the surface of the body in such a state of constitution, which must therefore be collected in the larger veins about the heart. But if the heart were to throw out its whole contents at each systole, the velocity of the blood in the arteries would be immense, and must be then forced into the small vessels on the surface of the body, which it certainly is not. A quick hard vibratory pulse is generally attendant on inflammation. The fulness or emptiness of the pulse depend greatly on the parts that are affected, which either increase or decrease the irritability.

Different Parts produce different states of the Pulse.—In inflammation of common parts, as the skin, cellular membrane, muscles, &c., the pulse will be full and strong, and the symptoms acute, especially if near the heart. Ligaments, cartilages, tendons, and bony parts produce symptoms which are less acute; the pulse is not so full, but quicker, there being in these cases a greater degree of irritability. In the vital parts of the second order, as the brain, the

pulse is soft and slow ; but in the stomach and parts with which it sympathizes greatly, as the testicles, upper part of the intestines, &c., the pulse is small, quick, and contracted.

Of the sensations arising from inflammation in different parts.—

When the injury is in the head, the pain is often dull and attended with sickness ; when in the heart and lungs, the pain is more violent. When in the stomach or upper part of the intestines, it is a heavy depressing pain, and attended with more or less of sickness. When in the colon it is more acute, but attended with less sickness. When the liver, ligaments, or bony parts are affected, the pain is much the same as when the stomach is affected, that is, heavy and depressing : the pain is acute and rousing when the skin, cellular membrane, or muscles are inflamed.

Inflammations in vital parts do not all produce the same effects on the constitution, which would seem to arise from their greater or less sympathy with the stomach ; but it is certain that a given quantity of inflammation in a vital part or its sympathizer will produce much more considerable effects than a greater quantity in another part, and the blood will be more sizzly. When the heart is inflamed, its actions are irregular ; if the lungs only are inflamed, the heart still seems to sympathize, and is irregular in its actions, as well as weak. If the stomach is inflamed, the patient feels a depression and a defective action in the heart as well as in every part ; simple animal life, or the living principle, seems then to be depressed, as the sensitive from inflammation in the brain, and the pulse is low and weak. In inflammation of the uterus the pain is very acute, and the pulse quick and low, the stomach sick, &c. When inflammation occurs in these parts the symptoms come on very quickly ; and if it proves fatal, it runs through its stage very fast ; debility beginning very early. All this may depend on the stomach being, as it were, the central seat of sympathy, whence the actions of life are interfered with. However, universal sympathy soon takes place here, and the sympathy being similar to the first action, a fever of a depressing kind is produced, and death soon succeeds.

Inflammation of parts not vital, of such violence as to affect the actions of life by general sympathy, render the pulse full and strong. The constitution in this case is strong and not irritable ; for when weak and irritable, the pulse is quick, hard, and small in the beginning, as it is in inflammation of vital parts, and the blood though sizzly is loose in its texture.

Difference from different nerves.—One cause of the difference in the inflammation of vital parts seems to be the different systems of nerves by which they are supplied. In all those parts supplied by the par vagum, inflammation affects the patient with lowness from the first, these nerves supplying the parts of involuntary motion, and therefore possessing the living principle in the highest degree ; whence an inflammation of these parts becomes peculiarly depressing.

Situation of the blood in the commencement of diseases.—In some diseases the blood at first forsakes the skin, extremities, and lips, and

the parts shrink and diminish in bulk ; this is particularly evident in the eye, and arises from want of power in the constitution, all the powers being called to the citadel, or source of power, and the outworks left. This happens in fainting, agues, hectic, &c., and does not seem to arise from debility at first, but from a novelty of action, and a consequent inability to perform it. In putrid fevers the external parts first loose their living power from having a less resisting power.

Of the Effects on the Constitution from different stages of Inflammation.—The constitutional effects arising from inflammation, independent of the difference of parts, situation, nerves, &c., are more or less according to the stage of the disease. When inflammation is in the adhesive stage, it has but little effect on the whole system, and that effect is generally an increase of animal actions. This stage is the one which should be considered as truly inflammatory, as in it the constitution appears to be more regular, more determined, and more at ease, for it is more steady, more capable of continuing the time of action than in any other, hardly any varieties taking place in the time of this stage of the disease. When the suppurative stage comes on, the effects on the constitution are much more considerable and more various. Cold fits or rigors are generally felt on the commencement of suppuration ; but they are not lasting, and are often succeeded by hot fits, both being more or less according to the greatness of the present inflammation and the suppuration that is likely to follow, as indeed with the nature of the parts, and their situation, whether vital or not, &c.

Cold fits show plainly the commencement of some new action, as the beginning of fever, the absorption of poison, or even from simple irritation, as pricking the finger with a clean needle. They may also be produced by disagreeable sensations and disagreeable states of the mind. These rigors are probably dependent on the stomach, which being the seat of simple animal life and the seat of sympathy, takes part in every constitutional alteration, and we observe how much this viscus is affected by loss of blood, disagreeable sights, &c. What nature intends to effect by this sympathy with the rest of the body it is hard to say, but it is worthy inquiry whether she may not intend to relieve herself by rousing the actions of life by means of vomiting. Rigors seem to be the effect of any new action in the constitution, and not at the commencement of a disease only, for even at the close, changing from a diseased action to a healthy one will cause rigors to take place. In a strong constitution, where rigors occur in consequence of a well-formed fever, the consequent actions of a hot fit and sweating go on regularly ; but in a weak constitution there is much loss of power by each rigor, and they will not be followed by a hot fit, but only perhaps by a little sweating.

A boy was attacked with rigor, followed by sweating, and he afterwards continued getting sensibly worse and worse : pulse quick and full, blood sizy, tongue white. He was worse every

other day. After being ill a fortnight, he was again attacked with rigor, hot fit, and sweating, which, contrary to my expectation, who supposed these would be repeated, carried off the disease with that single fit. I think I have seen other cases where Nature has attempted something like this, but has failed.

In many cases the rigor is the first apparent symptom, and is followed by a hot fit, and then sweating, and when these whole actions of the disease have taken place the patient becomes well; but this is not the case where, from weakness, &c., the whole regular actions do not take place, but, as at the commencement of the boy's case above related, the hot fit does not succeed the rigor, and he continued ill afterwards until Nature again took on the rigor, and he was able to go through the stages regularly, and one fit carried off the disease. The boy above mentioned was also a striking instance of the crisis of a disease being like its commencement.

Rigors from a local affection are seldom followed by a hot and sweating stage, and the bark in such cases can be of little service.

The ulcerative stage seldom affects the whole system; but that rigors take place on the commencement of ulceration is, I think, certain, although it cannot be well perceived in all cases, for ulceration will follow so close on suppuration in most cases that it will be difficult to distinguish which was the cause of the rigors. But when suppuration has taken place, and the abscess been opened, (so that the act of suppuration is finished,) yet not so opened as to afford a ready outlet to the matter, the pressure of the matter against the most depending part of the abscess will cause ulceration, and thereby rigors will take place; but these rigors will not take place for some time after the first opening, for the first opening will for a time remove the disposition for ulceration all over the surface of the abscess; but when it finds this opening not sufficient to take off the pressure, it then sets to work to make another, and the rigors return. Many have supposed from these rigors that new matter was forming.

Exacerbations are other symptoms, which have a great affinity to the foregoing, and are common to most constitutional diseases, and to some local ones. They are repetitions of the first attack, but seldom so strong as the first. These have been supposed to be owing to the disease acting on the constitution at stated times; but we must search for some principle in the animal economy to account for this, for we cannot suppose an increase and decrease in the cause of disease to account for it. Agues exist in the constitution as much between the fits as in them. If the constitution is strong, the exacerbations are regular; if weak, irregular. These may be partly owing to the fact that an animal cannot exist for long together in the same state; life cannot always be affected in the same way.

Of the state of the blood in Inflammation.—It is reasonable to suppose that the blood is affected in the same manner with the con-

stitution, and that disease has nearly the same effect on it that it has on the body, because the same living principle runs through the whole. We find this to be really the case; for till the disease has affected the constitution the blood continues the same as before; but as the constitution becomes affected the blood also becomes affected, and undergoes changes which are probably owing to contiguous sympathy between the vessels and the blood. So that we shall find that the changes in the blood are often as expressive of disease as in any other part of the body. When the action of the solids is of the inflammatory kind, or what is perhaps the same thing, when there is too great action of the solids, the blood under such a disease more readily admits of a separation of its component parts (see p. 32, *note*); the red particles subside more to the bottom of the coagulum, and the coagulation of the lymph, though more slow, is firmer; the upper part of the coagulum being of an opaque white, in which state the blood is said to be *sizy*. It is not easy to say whether this change in the blood is not the first produced, and that the constitutional is not an effect of the change. I have before said that I can conceive the death of the blood to take place independently of the solids, and it appears to me that the diseased state of the blood is capable of coming on as suddenly as the corresponding state of the solids.

A man received a stab in the abdomen. I saw him a little time after the accident, when there was no degree of fever or constitutional affection, but he complained of considerable pain; I therefore took away some blood from him, which was entirely in the natural state: in about a quarter of an hour constitutional disturbance came on, and the blood appeared very *sizy*.

Whether the disposition for inflammation and the change produced in the blood arise from a real increase of animal life, or whether it is only an increase of the disposition to act with the power that the machine is already in possession of, is not easily determined: but it appears certain that it is either the one or the other. However, some circumstances incline me to suspect that it is the last, because we often have inflammation when the powers are but weak, where there appears to be only an exertion of very weak powers, arising from some irritation produced. This appears to be equally the case in local inflammation and inflammatory fever, or the symptomatic fever. On the other hand, there are some reasons for thinking it may be a real increase of animal life, for women who are breeding, and who are in perfect health, have yet *sizy* blood: and this is the case with all animals in a similar situation. Now it would appear necessary for an animal, when put into a situation where greater powers are wanted, that these powers should be increased. In breeding females there is a process going on which, though natural, is uncommon, and which requires a greater quantity of power than usual; therefore we have greater powers produced.

If these observations are just, the blood should not be inflammatory blood, but blood whose powers of life are increased.

On the other hand, where there is great debility in the solids, where the powers of preservation are less, and therefore action weak, where the body must therefore have a tendency to dissolution, we find the very reverse of the former appearance in the blood; there is no distinct separation, but the whole mass continues mixed. This effect takes place in those who die instantaneously, and I suspect that the blood dies first, and instantaneously.

When the pulse is quick and hard, and has a kind of vibratory thrill, we generally have sizzly blood. This may arise from fever, or such inflammation, &c., as affects the constitution or the vital parts, these being diseased, so as to keep up a constitutional irritation, which will always be an attending symptom.

But when we have neither a quick nor hard pulse, but rather small, no visible fever nor inflammation, but perhaps some strange and undetermined symptom, such as pain, which is moveable, sometimes in one place and sometimes in another, yet seeming to impede no natural function, we shall nevertheless, on bleeding, find the blood sizzly, as happened in a gentleman who had severe pain shifting about, with a small slow pulse: he was blooded, and the blood found sizzly. After the bleeding the blood became fuller and harder, and did so after every bleeding, which, on account of this circumstance and the continuance of the pains, was repeated several times. Something like this is observable when an oppressed pulse becomes liberated by bleeding; but what was remarkable here was its increasing in hardness. We may even have the blood contract so strongly in these cases as to cup. So that the pulse and the appearance of the blood do not always agree with one another.

The manner in which inflammation begins is generally from a point. It afterwards spreads from this in proportion to the violence and the disposition of the surrounding parts. This is the case in accidents; the accident is limited, but the inflammation arising from it is not; it is most violent in the first point and gets weaker and weaker as it spreads from this until it is lost insensibly in the surrounding parts. This extension is owing to sympathy; and hence, according to the susceptibility of sympathy will be the spreading; and from the difference of disposition to sympathy will result great differences as to the diffusion of inflammation; the more healthy the less the sympathy.

Swelling of the parts in inflammation, like the inflammation itself, is greatest in the middle, and gradually lessens from that till it is lost in the surrounding parts. It is owing to the extravasation of coagulable lymph and some serum being squeezed out as the coagulable lymph thickens, and is deposited around the inflamed part, causing œdema, which is less in proportion as the parts are healthy.

Of the colour of inflamed parts.—The colour of an inflamed part is visibly changed from the natural hue, whatever it was, to red. This red is of various hues, according to the nature of the inflam-

mation; if healthy, of a pure scarlet red; if less healthy, the colour is rather more of a purple, and so on till it shall be of a bluish purple.

This increase of red would appear to arise from two causes; first, dilatation of the vessels, by which a greater quantity of blood is sent into those vessels which naturally admit only serum or lymph (an example of which we have in the conjunctiva of the eye when inflamed); and secondly, the formation of new vessels in the extravasated uniting coagulable lymph. From which circumstances there is a greater quantity of blood in the part than in a natural state, according to that law of the animal economy, that where a part has more to do than to support itself, red blood is thrown into it in larger quantities.

The true inflammatory colour is scarlet, that colour which the blood has in the arteries; hence we should suppose that the arteries were chiefly dilated, or if the veins are equally distended, that the blood undergoes no change in such an inflammation in the passage from the arteries into the veins, which last I think most probably the case.

Heat of the inflamed part.—The inflamed part is hotter than common; but this is most obvious in the skin, from its being a part most disposed to carry these sensations to the brain. Heat, I imagine, is a sign of strength and power in the constitution, though it may often arise from increased action in weak constitutions or weakened parts. It is an immediate action, while cold is the reverse, and often arises from a diminished action of strong parts. It has not been considered whether an animal has this power equally in every part of his body, though from what is generally advanced on this subject, it is probable that it exists in every part. Nevertheless, I am inclined to suspect that there is a principal source of heat, though I do not think with many that this source is in the blood, but rather that this is affected by the source of the blood being near to the source of heat.

That this principle resides in the stomach is probable; at least of this I am certain, that affections of the stomach will produce either heat or cold. Eructations often give a sensation of heat, but whether this is increased heat, or only a sensation, it is difficult to say. Certain substances taken into the stomach produce a glow. Certain affections of the mind also produce a glow. This would appear to contradict my opinion, but I suspect that the stomach sympathizes with the mind.

We find that inflamed parts become hotter; but let us see how far the increase goes. From all the observations I have made, I do not find that a local inflammation can produce local heat above that which is natural to the animal; and when in parts whose natural heat is inferior to that which is at the source of the circulation, it does not rise so high. A man had the tunica vaginalis laid open for the cure of hydrocele; I introduced a thermometer into the wound, and placed it in contact with the testicle, and it stood

at 92° ; by night it had risen to $98\frac{1}{2}^{\circ}$, a rise of $6\frac{1}{2}^{\circ}$: but this is not greater than the heat of the blood at the source of the circulation. A wound was made in the belly of a dog, and the bulb of the thermometer immediately applied to the diaphragm, which gave 101° , and did not increase above that. Another dog's rectum gave 102° , and when inflamed very much, which it was by injecting a solution of corrosive sublimate, the heat was not increased a degree. The rectum of an ass, 98° , was injected with a strong infusion of mustard and ginger several times repeated, but without increasing the heat at all, nor did a strong solution of corrosive sublimate have this effect: at last a much stronger one was injected, which brought on a very violent inflammation, but the heat was only increased to 100° . A similar experiment was made with nearly the same result on the vagina of the same ass. Also a wound was made deep in the gluteus muscle of the same ass, and in no stage of this wound did it raise the thermometer above 100° . A wound was made in the belly of the same ass, and an injection of a strong solution of common salt thrown into the belly, which produced violent inflammation, and even symptomatic fever; yet the heat of the part was very little altered. From all which observations and experiments I do not find that a local inflammation can increase local heat above the natural heat of the animal; and when in parts where the natural heat is inferior to that at the source of the circulation, it does not rise even so high. Yet, that in some instances the heat of the parts may be increased beyond its natural degree in those parts which have the greatest natural heat, is certain from the following experiment; the bulb of the thermometer being held in the stream flowing from the abdomen of a man tapped for dropsy raised the mercury to 104° . In most of the above experiments there seemed a difference of 1° between the heat at night and in the morning, and this difference seems to exist in the natural state of the body.

I suspect that the blood has an ultimate standard of heat in itself when in health, and that nothing can increase that heat but some universal or constitutional affection, and that the whole power of local inflammation is only to increase it a little in the part, but cannot bring it above the standard heat of the constitution, nor even to it in parts far from the source.

Of Cold.—The production of cold certainly is an operation which the more perfect animals have a power of performing. (See p. 82, *note*.)

I suspect that coldness in disease arises from weakness of the whole constitution, joined with a peculiar mode of action at the time. That universal or constitutional cold arises from the stomach is evident, for whenever we are made sick universal coldness takes place. This is best proved by producing sickness in animals that we can kill while under the influence of the affection of the stomach. I threw three grains of emetic tartar into the stomach of a bitch, and repeated the experiment with a grain more: she vomited and

strained very hard, and brought off a good deal of froth, that is mucus, from the stomach, mixed with air in coming up. I opened her body, and, contrary to what we generally observe, I found the intestines, liver, and heart not warm. I have known people who had affection of the stomach say that they had plainly a feeling of coldness in their belly. I knew a gentleman who said, whenever he threw wind off his stomach it felt cold even to his hand.

Affections of the mind also produce general coldness, but such effects arise from the sympathy of the stomach with the mind, producing there such a sensation as we mean by the expression "turning the stomach with sickness:" the sensation proceeds to the shoulders, which, with the rest of the body, are put into motion by what we term shuddering.

Of Pain in Inflamed Parts.—The immediate cause of sensation is an alteration in the natural position of the solids, arising either from violent action or mechanical or chemical effects,* joined with its being produced in a given time; for this alteration may be produced so slowly as not to keep pace with sensation, as in many

* [It must be confessed that we are very much in the dark respecting the proximate cause of pain; for being ignorant of the ultimate distribution of the nerves, as well as of their mode of action, we cannot say in what manner they may be affected; indeed, we cannot positively say that pain depends on the nerves at all, for those parts which are most painful when inflamed have the fewest nerves, and these do not enlarge in consequence of inflammation in the same manner that the vessels do.

Pressure is a well-known cause of pain, and therefore has been assigned as the cause of pain in inflammation, for not only are the minute vessels distended from within and pressed upon without, but the natural sensibility of the parts is exalted by the increased vascularity. This is further confirmed by the exquisite pain occasioned by inflammation when it occurs in any unyielding texture, as the teeth, the bones, the periosteum, the serous and fibrous membranes, &c., as well as by the relief which is afforded by such means as tend to diminish the tension of the inflamed parts, as bleeding, scarifications, fomentations, &c. It may, however, be urged on the other side, that the pain is not proportioned to the quantity of nerves, as in fibrous membranes, bone, teeth, &c.; nor to the quantity of effusion and consequent swelling, as in serous membranes; nor to the quantity of inflammation present, as in gout, rheumatism, &c.: that the difference in the quality of the pain is inconsistent with any mechanical explanation, which would occasion differences in degree but not in kind; that it is irreconcilable with the sudden transition of pain from one part to another, as in metastasis; that chemical substances cannot be supposed to act in this way; and finally, that pain often occurs without its being possible to assign any probable source of pressure as a cause, as in colic, tic-douloureux, tooth-ache, and many other forms of nervous disorders.

It seems, therefore, most probable that pain depends on some peculiar action of the nerves with which we are unacquainted, but to which pressure stands in the relation of an exciting cause.

Pain is the most general symptom of inflammation. What other purpose does it answer besides that of inducing the patient to repose the inflamed part? Does it answer any *direct* purpose in the economy? Intense pain occasions increased vascularity of the affected part, and if continued, excites inflammation. This is seen in tooth-ache and tic-douloureux, which inflame the face, and in disease of the hip, which occasions inflammation of the knee; on the other hand, whatever diminishes the pain diminishes the inflammation also.]

indolent tumours; or, on the other hand, this alteration in the natural position of the parts may be so quick as to exceed sensation. (See p. 56.)

Pain is not the same in all the stages of inflammation. In the adhesive stage it is generally but inconsiderable, especially if it is to go no further, and is perhaps more a heavy than an acute pain. But when the inflammation is passing from the adhesive to the suppurative, the parts are undergoing greater change, and the pain gets more and more acute until it becomes very considerable and becomes pulsatory, being increased during the dilatation of the arteries. The nerves, too, acquire a degree of irritability which renders them much more susceptible of impression than in a natural state. When suppuration has taken place, the pain in some degree subsides; however, as ulceration begins, it in some degree keeps up the pain, and this more or less according to the quickness of the ulceration. The pain attending ulceration gives more the feeling of soreness.

Of the Subsidence of Inflammation.—Whatever disposition it is which produces inflammation, and whatever the actions are which are produced by this disposition, yet when the disposition arises either from the constitution or part, it can be removed, and of course the actions raised in consequence of it cease.

If the disposition for inflammation has taken place, and the vessels, which are the active parts, should have dilated thoroughly, they will allow the blood to enter them, so that the part shall look red; but no hardness or fulness shall be observed, and the whole will subside before adhesions have taken place: or if inflammation is gone so far as to produce swelling, which is the adhesive state of the disease, yet by certain methods it can be assuaged, and suppuration be prevented from taking place, and then the parts will fall back into their natural state, which is called resolution. And as the first symptom of inflammation is pain, the first symptom of resolution is the cessation of pain.

Why an inflammation of any kind should cease after it is once begun is very difficult to explain, or even to form an idea of, unless it is on the principle of what I call custom that the parts adapt themselves in time to their present situation; and therefore, in order to keep up inflammation, it is necessary that the cause should increase in proportion as the parts become reconciled to their present circumstances. But this will not account for their returning to their original state when this increased irritation ceases. We may suppose that the removal of the original cause is sufficient to stop the progress of inflammation; and when stopped, the parts cannot easily remain in the inflamed state, but by their own efforts begin to restore themselves to health, like a spring which is bent by a weight, but the moment the weight is removed the spring returns to its former state.

Restoration of injured parts.—All alterations in the animal frame arise from a disposition to act, and these preternatural actions, in consequence of injuries, may be caused,—1st, by a disposition to

restoration, in consequence of injuries, which is the most simple ; 2d, by a disposition of necessity, as thickening of parts, ulceration, &c., which is rather more compounded : 3d, by disease, which is the most complicated (p. 97.) There are a great many cases requiring the assistance of a surgeon but which cannot be strictly called disease, but are injuries done to the body. In disease there is a disposition to wrong action, which goes on until the disposition is worn out, or is put a stop to by remedies ; but the actions in consequence of accident are widely different, for here, by reason of the stimulus of imperfection in the injured part, a disposition to restoration is excited, and action, different from the former comes on. In disease the restoration to health is produced by a prevention of the continuance of diseased action ; in injuries, or alteration of structure by violence, something is required different from the ordinary and natural actions, which will differ in some respects according to the nature of the violence and of the part ; and this alteration is of the most simple nature, being the action in consequence of a disposition to restoration, and consequently if it requires any assistance from art, it is of the most simple kind. The affections from accidents may be divided into two kinds, those which take place in sound parts, and those in parts before diseased. The first I shall only treat of now. Accidents, then, may be divided into two kinds ; first, those which do not communicate externally, as bruises, sprains, ruptured tendons, simple fractures, &c. ; secondly, those which have also an external communication, as compound fractures, wounds, &c. ; yet these may be, and often are, brought under the first head. Bruises, which have destroyed the life of a part, might be considered as forming a third head. The first class, when in a simple state, requires a most simple treatment ; but they may be so complicated as to require our utmost exertion. The most simple of these is the bruise, when the continuity of parts is not broken through ; here the parts have nothing to do but recover themselves. The rupture of a small vessel is next, the blood being effused into the cellular membrane ; but the vessel must not be in a part of any consequence to life, or the extravasation may kill, as in the arteries of the brain. The cure in this case will be next in simplicity, the vessel being closed by the contraction of its muscular coats, and the union effected by means of coagulable lymph, and the extravasated blood being taken up by the absorbents. The differences in these cases will arise from the magnitude of the injury and the nature of the injured parts. Some accidents of the first class, as fractures, will require the aid of a surgeon to restore the parts to their natural situation, and then nature falls to work and completes the business. Sometimes the quantity of blood extravasated is so large as to prevent nature from going through these processes directly, and forms a tumour called an ecchymosis. Ecchymosis may be said to be of two kinds ; one is where the blood coagulates ; the other where it does not. That which coagulates commonly subsides gradually, from the blood being absorbed, and gives but

little trouble, which is likewise the case sometimes with those in which the blood does not coagulate, though not generally. I have seen where a small wound has led to the cavity containing the coagulum, which not being meddled with, the sides of the cavity have gradually contracted, and have as gradually squeezed out the coagulum.

A woman fell with the labium pudendi on the edge of a pail. I found a very considerable tumour, which I thought was of blood; there was evidently a fluctuation. I bled her, and ordered a poultice, but did not open it, as I thought the presence of the extravasated blood might serve to stop the orifice of the vessel. In a little time the tumour burst, with a small opening, and on examining with a probe I found the coagulum filling a space the size of a goose's egg. The cavity grew less and less, but always kept exactly filled with coagulated blood; and thus it continued diminishing until the orifice healed. Thus the blood being allowed to remain in the cavity, and not acting there as an extraneous body, nor even allowing the stimulus of an imperfect cavity or inflamed surface to take place, the cavity continued to contract all round the blood until the whole had disappeared. Now what would have been the consequence if I had followed the old method of laying open the tumour, scooping out the blood and dressing the internal surface with turpentine? I should have had a sore of the whole extent of the tumour, and given considerably more trouble both to the patient and to myself.

The second species of ecchymosis, or that where the blood does not coagulate, does not always terminate so well as the former. It has often the appearance of an encysted tumour, but from being the immediate consequence of some accident to the part its nature is understood. The cause of this blood not coagulating must arise, I conceive, from some peculiar mode of action of the vessels arising from the injury, for I apprehend that in such cases the blood dies as it is extravasated, or in the act of extravasation, like the menses. This species of ecchymosis happens very commonly to children in birth under the scalp. In such cases nothing should be done but to wait with patience, and the whole will be absorbed. In many cases the accident has been so violent as to deaden the cellular membrane under the skin, or as to produce inflammation in the surrounding parts; these sometimes resolve, but they are seldom allowed to do so; for surgeons are led to open them early, from seeing the inflammation and feeling fluctuation, two strong enticements to use the lancet when all circumstances are not well attended to. But in such cases I should wait until I saw the signs of suppuration, viz., thinning of the skin over the matter and pointing of the contents, which are the only true marks of the formation of matter and of its approaching the skin.

Sometimes ecchymoses are removed by pressure, which without this would remain. Parts cannot bear pressure, so that the extravasated blood being pressed against the sides of the cavity, the absorbent vessels are under the necessity of absorbing it.

When ecchymoses are not absorbed, but suppurate, abscesses are formed, which must be treated as abscesses in common, only

waiting with a little more patience than when wholly the consequence of inflammation. In many of those cases of accident not only the skin shall be deadened, in consequence of which it will slough and leave a sore, but often the skin shall preserve its living powers, and only the cellular membrane underneath shall be deadened and slough, and produce an abscess, which was not at first expected. In cases where the skin in one part is killed by a blow, and the cellular membrane in another part, while the skin over it will remain sound, the deadened skin will come off, granulate, and heal kindly; but then inflammation shall take place, perhaps, an inch or two from it, where the cellular membrane was deadened, and an abscess shall be produced.

If these injuries are not very great, little effect will be produced on the sensitive principle, no sympathy or irritation taking place; but sometimes the accident will, by its irritation, produce another action of the parts, causing inflammation, the end of which is either adhesion of the divided parts or suppuration for getting rid of the substances become extraneous. The most simple accident may be attended with such circumstances as will prevent the more simple process of nature from taking place; such, for instance, as the magnitude of the vessel ruptured, or a fractured rib wounding the lungs, &c.

The second division I made was where wounds communicate externally.—These are subject to greater variety than the former, yet often admit of the same mode of cure. A wound may be either simple or compound. The simple, which is what I mean to speak of now, is a solution of continuity in a part, which must be made with a cutting instrument. In such cases a number of vessels are always divided, blood is effused, and the cells of the cellular membrane exposed, as well as other internal parts. The former class required only rest, but in these there is a necessity for replacing the divided parts. The present class admit of both a natural and an artificial cure. By the natural is meant union by the first intention; when this cannot be obtained, a new bond of union takes place—adhesive inflammation;* and if this is lost, a third mode—granulation. In that by art we have to imitate the natural, we are to bring the divided surfaces into contact; the living extravasated blood being then retained and coagulating, unites them; the mouths of the vessels shut, and the remaining blood is absorbed: the red globules are indeed absorbed, and only the coagulable lymph remaining becomes the bond of union.† This is an imitation of

* [Union by the first intention and adhesive inflammation are in the present day generally considered to be synonymous.]

† [It has been before observed that the blood does not become vascular, but only the coagulable lymph which is subsequently effused. The blood at first serves the useful purpose of uniting the divided parts; but beyond this it unquestionably is an impediment to union by the first intention. Wherever, therefore, union by the first intention is desired, the incised surfaces should first be cleansed of adhering blood previously to their being put into apposition. This rule of practice is universal.]

nature; but surfaces cannot always be brought to unite in this manner, and the blood in some parts loses its living principle, and then it becomes a source of irritation, exciting inflammation, which is the case sometimes in simple fractures, and which I shall call, for distinction's sake, simple compound fractures.

The best time of replacing the divided parts is perhaps during the time that the extravasation continues, but it may also be done when the discharge of coagulable lymph in the adhesive or first stage of inflammation takes place. Sometimes the inflammation runs so high as to get into the suppurative stage; the extravasated fluids may lose their living principle, and become a stimulus exciting inflammation.

By adhesive inflammation different parts of the body may be united to another by coming into contact; but the most extraordinary union is that of removing parts from one body and uniting them to another. Here is the testicle of a cock, separated from that animal, and put through a wound made for that purpose, into the belly of a hen; which mode of turning hens into cocks is much such an improvement for its utility as that of Dean Swift when he proposed to obtain a breed of sheep without wool. The hen was afterwards killed, and the testicle was found adhering to the intestines, as may be seen in this preparation, where the parts are preserved. Here is another preparation, in which the spur of a cock has been inserted into the comb of another; and here a human tooth, inserted into the same part, and united by means of vessels, which you see injected, from one to the other. These living bodies thus applied to each other produce adhesive, not suppurative inflammation. In the same manner, the eggs of one animal laid in the flesh of another do not excite suppurative inflammation. This would not be the case if the inserted body did not contain the principle of life, for the part would run into suppurative inflammation, as would be the case with a pea so introduced. While the guinea-worm is endowed with the living principle it gives but little trouble; yet if killed it gives the stimulus of an extraneous body, which produces suppuration through its whole length.

In this preparation you see a maggot deposited, just below the skin, on the back of a reindeer: here the first stage of inflammation took place only; coagulable lymph was poured out, which has formed a chamber in which the insect resided. A similar power is observable in vegetables. Here is an oak leaf, which I picked up in my garden; you observe on it seven or eight protuberances, exactly circular and uniform. These have been formed by the insertion of the eggs of an insect into the leaf; and I cannot but think the process would have been different if any substance not possessed of the vital principle had been inserted. It is on this principle of union by the first intention that the union of parts by suture has been recommended, which has been found the best practice where it can be done. The dry suture in superficial wounds answer very well, the quilled is sometimes useful, and the inter-

rupted is very often useful. The two last are properly called sutures. In many cases it is improper to keep the surfaces together, as when the wound has been attended with considerable contusion, which generally occasions sloughing of the parts. When much blood is extravasated, suppuration becomes necessary, in consequence of the blood acting like any other extraneous body; but when laceration only is present, union by the first intention may take place, especially when on the head and over other superficial bones, as Mr. Cline has observed. The machine is not at all disturbed by this most simple operation; there being perhaps even no local action except the contraction of the vessels, the union being performed by the blood only.

CHAPTER XIII.

OF ADHESIVE INFLAMMATION.

Natural tendency of inflammation.—Definition of inflammation.—Seat of inflammation.—Adhesive inflammation;—why limited, and how;—its tendency;—arising more easily in some parts than others;—lymph affected by the state of the parts secreting it;—appearances of inflammation;—redness;—swelling;—pain.—Adhesive inflammation; its use, in large cavities;—in the cellular membrane;—in the lungs;—compared with erysipelatous inflammation;—sometimes imperfect;—consequences of this imperfection;—constitutional effects of this inflammation.—Of resolution;—cases in which it is supposed to be improper;—modes of by constitutional means;—by weakening;—by temporary weakness;—by lessening irritability.—Venesection;—medicines;—local applications.—Treatment of adhesive when about to end in suppurative inflammation.

ALTHOUGH inflammation is an action produced for the restoration of the most simple injury in sound parts that exceeds union by the first intention, we must still look upon it as one of the most simple operations of nature. It is to be considered only as a disturbed state of parts, which require a new but salutary mode of action to restore parts to that state in which the natural mode of action will be necessary. But this same operation can and does vary, and is often carried much further than union, according to circumstances: and is often attended with disease, and that of various kinds, by which means it becomes more and more complicated. It becomes therefore necessary to begin by describing it in its most simple form, and with its most general effect, and to particularize further as we go on.

I shall call everything inflammation that produces the following local effects, viz., pain, swelling, and redness, all depending on one cause, and occurring at the same time. Out of inflammation arise many other local effects, which may be called secondary; such as

adhesions, suppuration, ulceration, and even death or mortification in the part, and universal affection, such as sympathetic fever, and universal death.

The act of inflammation is, as I have said, most probably in the smaller vessels. What the action is, or in what it differs from the common action of these vessels, is not easily ascertained; for we are better able to judge of the immediate effects than of the immediate cause.

Hitherto I have only shown that this inflammation takes its rise, and is capable of uniting parts, when preternaturally divided, but we shall find that it is capable of arising from very different causes, and that it is capable of producing adhesions in whole parts, or in natural separations, such as common cellular membrane, large circumscribed cavities, joints, &c., and these effects will be found to answer very important purposes.

As the adhesive inflammation precedes the suppurative in every part excepting the outlets, and the suppurative the ulcerative, the propriety of following this order of nature in treating of them will appear evident.

ADHESIVE INFLAMMATION.—If the actions of adhesive inflammation were allowed to extend themselves, it would prove more hurtful than any good that could arise from it; hence there are natural obstructions to its extending, which we shall first consider.

Natural Causes of the limiting of Adhesive Inflammation.—I have already observed that exposure of internal surfaces becomes the immediate cause of inflammation; that when it extends further than the exposed surface it is by continuous sympathy; and that when a whole cavity is wholly exposed, the whole would take on inflammation. We may now observe, that whenever a cavity is opened, the simple contact of its sides, or even the simple contact of these with any other living part, will set bounds to the immediate cause, which is the exposure.

To explain this further, we may observe that there is no such thing in an animal as an empty space in any of the circumscribed cavities of the animal body, exclusive of the outlets or reservoirs, which are imperfect, not being circumscribed. Every other part of an animal is either connected by the cohesion of one part with another, or by simple contact. This holds good too in the cellular membrane as well as the circumscribed cavities: for if a wound is made into either, we find that the surfaces of both, beyond the cut edges, are entire, and generally in contact with one another.

To explain this position, let me instance a case. If we make a wound into the cavity of the belly, in a sound state of those parts we shall find every viscus is in contact with some other viscus, and that the whole inside of the peritoneum is in contact with the viscera, so that no space is unfilled. If this wound is not allowed to heal by the first intention, still we find that no inflammation will take place, or extend further than the attachment of those parts to the cut

edges, excepting what is owing to continuous sympathy. If this were not the case, every part of the cavity must inflame, because every part would be equally exposed; and if the contact were removed at the time of receiving the wound, or at any time afterwards, the whole cavity must inflame, every part being in the same predicament as regards exposure.

The same thing would happen in the cellular membrane, if those cells were not in a natural state in contact, and inflammation would as readily extend over the surface of each cell as air does when blown into part.

Inflammation, then, takes place at the edges of the exposed parts in order to preserve this contact, as well as to serve as a basis for future operations: and in cases of spontaneous inflammation of circumscribed cavities, we find that where this contact is completest the inflammation and its consequences are the least; as in the belly, in cases of peritoneal inflammation, the inflammation is greatest in the angles between the viscera, where the parts are not so well in contact.

The effect of simple contact, in excluding the irritation from extending, was well illustrated in a woman who had the Cæsarian operation performed. After the child was extracted, the wound could not be brought together well, therefore so far gave rise to peritoneal inflammation; but the belly closing and falling in on its contents, the whole came in contact as before. The woman lived twenty-six hours, which gave time for the inflammation to take place. After death it was found that the intestines were united to the peritoneum all round the wound, for above half an inch in breadth, and the surface of the intestines, which lay unattached at the bottom of the wound, was inflamed, while every other viscus, as also the peritoneum beyond the adhesions, were free from inflammation.

The adhesive inflammation seems to be nearly of the same nature, whether it arises from the constitution, from a particular disposition of the part, or from some violence inflicted on the part; the final intention being nearly the same in all these cases, for in all it is an effect that has a tendency to repair an injury, as is evidently shown in many cases of violence, though it may not in all. Its utility is most obvious in those cases which arise from the constitution, or from disease in a part. When the adhesive inflammation arises from the constitution, it may be from some disease of that constitution; and, if so, it may be supposed to be of service to it, especially if it should be supposed to be the termination of an universal irritation in a local one, and by that means relieving the constitution of the former, as in gout. But where it is only a simple adhesive inflammation, I am rather apt to think that it is more a part of the disease than an act of the constitution, or termination of the disease. When it proceeds from a disposition in a part, it must be considered to arise from a disease of that part.

Although in all cases and in all parts the adhesive inflammation is not absolutely necessary and preparatory for the suppurative inflam-

mation, yet if it is in the cellular membrane or a circumscribed cavity, then its effects will prove salutary. It may indeed be considered absolutely necessary to prevent greater mischiefs, for very bad consequences would arise without it. The object of it in these parts is to unite the parts together for their future benefit by means of the coagulable lymph and serum thrown out, by which the extension of the suppuration will be limited.

It would appear from observation that some surfaces of the body have a much stronger disposition to throw out coagulable lymph than others; or we may view this effect in another light, that some surfaces of the body do not so readily unite by exudation of the coagulable lymph as others do, and therefore on such surfaces there is commonly a much larger quantity thrown out than probably would have been if union would have readily taken place. Thus we see in inflammations of the heart that the coagulable lymph is thrown out on the external surface in vast quantities, while at the same time the heart shall not adhere to the pericardium. This extravasated matter is always of the same nature with that of the parts which produced it, which is a curious fact. If the disposition of the part is cancerous, the extravasated coagulable lymph is a poison, for on being absorbed it contaminates the absorbent glands, producing cancer; and probably the same takes place in every poison that is capable of irritating to inflammation and extravasation.

Appearances of Adhesive Inflammation.—The part inflamed becomes redder than common, and redder and redder as it advances; the red being of a scarlet hue when the inflammation is healthy. The part becomes apparently more vascular than in a natural state, and most probably is really so, both from new vessels being set up in the old parts, and from the adventitious uniting substance becoming vascular. These new vessels become of use both in the state of adhesion and of suppuration; in the first to give powers of action to this new substance which assist in preventing suppuration, in the second to form a basis for the future granulations. In consequence of this extravasation the parts swell, which is generally in proportion to the inflammation, the swelling being probably most where the inflammation is greatest, that is, at the point of irritation, and it is gradually lost in the surrounding parts. The whole swelling appears like a part of the body a little changed, without containing any extraneous matter, and indeed is simply formed by extravasation of fluids, without their having undergone any material visible change.

Such inflammations as approach to the skin often produce vesications, which are filled with serum and often coagulable lymph, both which are sometimes tinged with red blood. This arises from the violence of the inflammation producing an apparent degree of weakness, approaching to a death, in the connexions between the cuticle and cutis, the life being in this part very weak, for in the beginning of mortification and of the putrefaction of dead bodies it

is produced. This connexion of the cuticle is more or less destroyed in every inflammation of the skin. We seldom see an inflammation attack the skin but the cuticle comes off sooner or later. We generally observe it peeling off in flakes after the inflammation has subsided.

The pain attending inflammation would not appear to be in all cases very acute, for many have very visible inflammations which do not give very much pain. However, this will vary according to the violence of the inflammation, or rather according to the quickness of its progress and its approach to suppuration; for when there is a quick dilatation of the vessels, and rapid extravasation of the juices, the sensations arising from such will be increased; but in cases where its progress is slow, as from indolent tumours, the mind is hardly sensible of its progress. That it must sometimes be very trifling is shown by the fact that on opening dead bodies we often find strong adhesions where the friends of these persons had never heard during life of a single complaint. We also see cases in which this inflammation arises from violence, where it gives very little pain. A man shall be shot through the abdomen, and, if none of the contained parts are materially hurt, the adhesive inflammation shall take place in all the internal parts contiguous to the wound, yet no degree of pain is felt from this process. In many bruises and in simple fractures the pain from the inflammation is very trifling, although there may be much laceration of the parts.*

Of the Uses of Adhesive Inflammation.—This inflammation may be said to arise in all cases from a state of the parts which they cannot remain in; therefore an irritation of imperfection takes place. It may be looked on as the effect of wise counsels proceeding from a consciousness of imperfection: nature is taking all the defensive precautions possible, for in all cases we shall evidently see it answer wise purposes, such as checking the suppurative inflammation, by making parts adhere which must otherwise fall into that state; and where this effect does not fully take place, it acts as a check to the extent of it, as we see in circumscribed cavities. In the tunica vaginalis, after the operation for hydrocele, the parts often collapse and unite to other parts of the same sac by adhesive inflammation, which prevents the suppuration extending over the

* [Redness, heat, pain, and swelling may each of them exist independently of inflammation; and when they arise from inflammation, they may exist in every possible relative proportion among themselves. In judging, therefore, of the presence or degree of inflammation, it is necessary to look at the whole symptoms collectively. The *redness* and *heat* are generally in proportion to the original vascularity of the part conjoined with the momentum of the circulation; the *pain* is greater in proportion to the denseness and inextensibility of the inflamed part, added to the acuteness of the attack and the quantity of nervous supply; the *swelling* is generally greatest where the reverse of these circumstances exists. Structure, however, is not the only circumstance which modifies these symptoms; they depend greatly on the specific nature of the inflammation: the sting of a wasp produces infinitely more pain and swelling than an attack of erysipelas.]

sac, so that partial collections of water again take place.* In still larger cavities, as the abdomen, where partial inflammations often take place, as after child-bearing or wounds of this cavity, we find this adhesion takes place, which either prevents suppuration altogether or unites the parts around it, and as the abscess enlarges the adhesive inflammation spreads, and thus excludes the general cavity. The same thing happens in inflammation of the pleura or surface of the lung. The cellular membrane everywhere in the body is united exactly in the same manner; the sides of the cells, as it were, sweat out the uniting matter, which, coming into contact with the opposite surfaces, joins them into one mass.

The lungs are subject to two modes of action in inflammation; being so circumstanced as to partake of the character of both orders of parts, the circumscribed cavity, and the secreting surface or outlet. The cellular membrane of the lungs readily admits of adhesive inflammation, like the cellular tissue elsewhere; but the inner surface of the air-cells, like the urethra, passes directly into the suppurative inflammation, and the matter which is thus formed is obliged to be coughed up. It is, perhaps, impossible to produce inflammation of the one without the other, which is, perhaps, the reason why inflammation of these parts is treated with such bad success.

We cannot give a better illustration of the use of the adhesions arising in consequence of this inflammation than to contrast it with the erysipelatous. How far this disease is to be ranked amongst inflammations I will not at present say; but it has some of the characters, as swelling, redness, pain, &c. The swelling arises, not from extravasation of coagulable lymph, but from serum: and it has other peculiarities, as being generally superficial, and spreading along the surface with an abrupt edge, which is, perhaps, owing to its specific character being always confined to the part affected. It has nothing of the adhesive character attending it which was not necessary; because this inflammation, being confined to the skin, seldom produces suppuration. But it sometimes happens, when erysipelatous inflammation attacks deeper-seated parts, that it suppurates; and when it does so, it appears often to be a forerunner of mortification.

A man was attacked with an inflammation on each side of the anus. It had such an appearance as might have been expected from the suppurative and erysipelatous inflammations joined; it had an œdematous appearance. He was bled, and the blood appeared very sizzly: he took physic, and was fomented. The next day the inflammation had reached the scrotum, where a fluctuation, with a gurgling of air, was felt. I now made an opening near the rectum, and in the scrotum, and let out a quantity of dirty-coloured matter. It continued to spread over the loins, scrotum, bottom of the abdo-

* [The old operation is here referred to, in which the tunica vaginalis was exposed by incision, and suffered to suppurate.]

men, &c., where I made openings, and out of which the cellular membrane hung like wet tow. In this case, the suppuration was diffused for want of the adhesive process preceding or accompanying it, by which means it would have been limited.

Adhesive Inflammation sometimes imperfect.—Sometimes it happens that the adhesive inflammation is so imperfect that it cannot set bounds to itself, and still less to the suppurative. This may be owing to two causes; first, the violence of the inflammation and quickness with which suppuration ensues, that is, before the parts have sufficiently united; secondly, the inflammation may be, as I suspect it is, of the erysipelatous kind, especially when there is a tendency from the beginning to mortification. This mixture of the suppurative with the adhesive, or hurrying on of the suppurative, I have often seen in the abdomen of women who have been attacked with peritoneal inflammation after child-birth; and when these circumstances become the cause of death, we find matter mixed with coagulable lymph, as if formed together.

The adhesive inflammation also takes place in cases where it is impossible it should produce the same good effects; as in wounds which are not allowed to heal by the first intention, as a stump after amputation, and many other parts. But it is one of those fixed and invariable principles of the animal machine, that, on all such irritations, the uniting process should be produced, although, like many other principles in the same machine, it cannot always produce the same salutary effects. So that although the wound is not allowed to, or cannot, heal by the adhesive inflammation, yet the parts go through the common actions consequent upon being wounded; first, they throw out blood, as if to unite the parts by the first intention; and then, the vessels contracting themselves, coagulable lymph, with serum, is thrown out, which has the effect, even in such wounds, of preventing a great extension of the inflammation, while the contraction of the vessels prevents the inflammation from running along their inner surfaces.*

Effects of Adhesive Inflammation on the Constitution.—These effects are very slight, even when the inflammation arises from violence; but the effects of those inflammations which are indolent in their progress are still more trifling in the constitution. This arises from the slowness of the alteration produced in the part, as it were, insensibly stealing on the constitution.

We know that one effect of adhesive inflammation is the uniting of parts not intended by nature to be united, and which must thus

* [One of the most remarkable good effects of the adhesive inflammation consists in the gluing of parts together previously to the discharge of hurtful matters from the body, as gall-stones, fæces, urine, &c., which are frequently discharged in this way; the ulcerative and adhesive processes proceeding *pari passu* to effect the discharge, at the same time that the latter always keeps a little ahead of the former. If it were not for this beautiful provision of Nature, the great cavities of the body would frequently be exposed to fatal inflammation from such causes.]

be made less moveable on one another: in fact, they must at first have little or no motion on one another, as occurs in the cellular membrane and circumscribed cavities: but it happens that motion is again obtained after a time by the elongation of the connecting part, which is effected by the repeated endeavours for motion. These uniting media are seen to become vascular. They are perhaps often the cause of many indescribable sensations, which cannot be called pain. In the heart they are the cause of palpitation, &c.

On the Resolution of Inflammation.—Since an animal body can be made to act improperly by impression, we can see no reason why, when acting improperly according to such impressions, it should not be made to act properly by the same mode, namely, by impression.

The cure of inflammation is resolution, and an attempt towards it, when in the adhesive state (for this is intended to prevent suppuration taking place), must be in general made only under the following circumstances, namely, when inflammation arises constitutionally, or from disease of the part. In cases of accident where there is no exposure, as also where there is, but that exposure is removed in time by bringing the parts into contact, and where the life of the parts has not been destroyed, in all such cases we find that resolution will readily take place.

It is commonly supposed that there are a great many local inflammations which should not be resolved. An inflammation arising from a preceding indisposition in the constitution, commonly called critical, has always been classed amongst those which are not to be resolved; it has been insisted on that the inflammation should rather be encouraged, and suppuration produced. But in such treatment it is always under the idea that the inflammation is in such parts as will readily admit of cure when suppuration takes place; for if the disease is otherwise situated, the cure of the constitution by suppuration will be a mode of cure which will reflect back another disease on the constitution, under which it will sink; therefore resolution in such situations should, if possible, be brought about. Many deep-seated inflammations, if allowed to suppurate, will, of themselves, most certainly kill: gout also, in the head or stomach, should always be resolved, and left to settle in some other part less connected with life. If inflammation is really a concentration of the constitutional complaint, and if, by not allowing it to rest there, the same disposition would really be diffused over the whole animal again, and would be liable to affect some other more important part, it would certainly be better to encourage it when in a proper part. Still it does not appear necessary that it should suppurate, for suppuration is only a consequence of inflammation; not an immediate effect of the original constitutional disease, but a secondary one. As suppuration, therefore, is only a thing super-added, and as we shall generally find that inflammation subsides as suppuration comes on, I see no reason why inflammation should not in the present case as well subside by resolution as by suppur-

tion. It may, however, be supposed, that as this suppuration is not a natural or immediate effect of the disease, yet as it is a continued local action, that it is capable of diverting the disease to the part. I hardly know an instance where inflammation from violence may not with propriety be resolved, and prevented from going into suppuration, except where it relieves the constitution from any prior disease. Thus, Mr. Foote was cured of a violent pain in his head by amputation of his leg; but he afterwards died with a different complaint in his head. Might not the first diseased action in the head be altered in this case, and an action of a different kind induced, which proceeded to the degree of effecting his death?

Of the Resolution of Inflammation by Constitutional means.—If the inflammation is of the true adhesive kind, the only thing to be done is to lessen everything that has a tendency to keep it up, because we know of no method that will entirely quiet or remove the inflammatory disposition, or mode of action;* there is no specific against inflammation that we are acquainted with. Whatever will lessen the power or disposition will lessen the effect.

There appear to be three methods which tend to remove inflammation: first, by weakening; secondly, by producing temporary weakness; thirdly, by lessening or soothing the irritability.

That which absolutely weakens is bleeding, purging, quietude, and low diet. The temporary weakness is produced by sickness at the stomach, faintness, &c. The soothing effect may be produced by sedatives, antispasmodics, &c., such as many sudorifics, anodynes, &c. The first will have the greatest, most immediate, and most lasting effects; the second and third act as auxiliaries; the second probably will come nearest to lessening the cause while the other will assist so far as irritation is a cause; they should go hand in hand, for wherever we lessen the power we should at the same time lessen the disposition for action. But neither bleeding, sickness, nor purging can possibly lessen the original inflammatory disposition:† by lessening the power of action of any disposition you only lessen or protract the effects, which, however, will be of singular service, as less mischief will be done, and will often give the disposition time to wear itself out.

Bleeding, then, at first may be necessary; but this must be done with some restriction. If inflammation arises from real powers, then bleeding freely is absolutely necessary; but if from too great action of weak parts, bleeding should be no more than what will just lessen the violence of the blood's motion, or remove the feeling

* [Mercury and colchicum are perhaps exceptions to this observation; at least they certainly subdue inflammatory action with extraordinary rapidity in many cases.]

† [In this instance the author has allowed reasoning and hypothesis to usurp the place of observation and fact. It is certainly not uncommon to witness the almost complete destruction of an inflammatory attack by a single copious venesection.]

in the part inflamed of too much to do. The quantity, therefore, must be according to the symptoms and other circumstances, that is, according to the visible indications. The indication for bleeding is, first, according to the violence of the inflammation, joined with the strength of the constitution: secondly, according to the disposition to form blood; thirdly, whether the disease is in a vital part: fourthly, its situation, whether near the heart or not; fifthly, according to the duration and the extent to which it has affected the constitution.*

With respect to the first kind, in which the constitution is strong and the inflammation is violent, bleeding largely is proper, and in many cases bleeding near the part will answer better than from the general habit; less may be taken away in this way with an equal effect on the part inflamed, and of course with less effect on the constitution, as bleeding from the temporal artery, or the jugular vein, for complaints of the brain, or cupping or applying leeches near the part, as, for example, to the temples in inflammation of the eyes.

The same mode of practice is to be followed with regard to the second, third, fourth, and fifth. It seldom happens that one bleeding will be sufficient in a considerable inflammation. The first blood taken affords a symptom of the disease; if it is buffy, thick, and considerably cupped, future bleedings may be used with less caution. On the other hand, there may be indications for bleeding sparingly; first, from there being too much action with weakened power; secondly, from a disposition to form little blood; thirdly, from the part being far from the source of the circulation.

A gentleman had a violent inflammation of the eye; the blood was sizzly, but though sizzly the coat was exceedingly tender, and so slight as not to bear its own weight when raised up. He was bled plentifully several times without any good. Here was not, then, much power, the blood putting on the sizzly appearance in consequence of there being increased action in the vessels of this part of the body.

* [The propriety of blood-letting is indicated by many other circumstances besides those pointed out in the text. I shall only mention three of these at present: the *first* arises from the structure of the part affected. Thus, serous and fibrous membranes require and bear venesection to an extent which would be perfectly unwarrantable in regard to mucous membranes. The *second* arises from the probable demands which will be made on the constitution during the future progress of the case. It would be extremely imprudent, for example, to bleed a patient with a severe compound fracture to the same extent which would be perfectly justifiable in inflammation of the eye. The *third* is derived from the act of venesection itself, as whether the blood flows freely and the state of syncope is easily induced; for it has been justly remarked that those inflammations which most require venesection *support* the constitution under considerable losses of blood, and enable it to bear them much more easily than it could have done in a state of health. In most cases of acute inflammation it is advisable to take such quantities of blood at first as shall make a decided impression on the constitution; one effectual bleeding being of infinitely more service in checking the disease than a number of successive bleedings to a smaller amount, at the same time that the powers of the general system are much less reduced.]

A lady with inflammation of the tonsils was blooded; the blood was sizzly, but loose; and after three bleedings the blood became so loose that the bark was given, which did service. The disorder returned again, and the same mode was used; the blood was sizzly only in the first bleeding; the bark was obliged to be again given.

In such cases bleeding is very seldom necessary. Where it is necessary, it should be as near the part as possible, in order that it may have the greatest effect on the part with the least damage to the constitution. If local bleeding be used, leeches will answer best, because but little inflammation follows their bite;* however, this can only be put in practice in inflammations which are pretty much external. In many cases we cannot take it immediately from the part, and must be content to go as near as we can, as in bleeding from the temporal artery or jugular vein, in affections of the head. Sometimes of course even this will be impossible, as in inflammations of the liver and stomach.

Too much action with small powers may often, if not always, be classed with the irritable, and bleeding here should be performed with very great caution. When inflammation is far from the source of the circulation the same precaution is hardly necessary, as in general it can be taken away from the part.

We cannot depend on sizzly blood alone as a proof of the propriety of repeating the bleeding; we must take into consideration also the strength of action.

The pulse is a great indication for bleeding in inflammation, but is not always to be relied on. In inflammations that are visible, the knowledge of the kind of inflammation is in some degree ascertained, in which cases it has been supposed that we go on surer grounds in our indications for bleeding. But all inflammations are not visible: therefore we require some other criterion. If we could ascertain the pulse peculiar to certain appearances in visible inflammations, and were sure that universally the same pulse attended such appearances, we should then suppose we had the true indicative criterion to go by, and be able to apply it to invisible inflammations, and judge of these by the pulse. But when we consider that the same kind of inflammations in every part of the body will not produce the same kind of pulse, but very different pulses not according to the inflammation, but according to the nature of the parts inflamed, and many of these parts are invisible, we see that we at once lose the criterion of the pulse as a guide. There may be every symptom of inflammation and the pulse be soft, and not quicker than usual, and yet the blood when taken away will be sizzly and cupped.

A lady had this kind of pulse (soft and not quick), and at the same time had a violent cough, with tightness of the chest and stitches in the side; bleeding was ordered, when the blood was found sizzly, &c.; nor did the illness subside till the sixth bleeding.

A hard quick pulse is generally an indication for bleeding, being

* [Cupping will generally be found more effectual where it is practicable, on account of the blood being more rapidly removed.]

frequently accompanied with sizzly blood ; but even these signs are not always to be depended on as furnishing a criterion. The kind of blood is of consequence to be known, for although it should be sizzly, if it is not firm in its texture, but lies squat in the dish, bleeding must be performed very sparingly.

As the pulse simply, independently of all other considerations, is not an absolute criterion to go by, and as a sizzly and strong coagulum is only an afterproof, let us see if there are any collateral circumstances that can throw some light on this subject, so as to enable us to judge, *à priori*, whether it is right to bleed where the pulse does not of itself indicate it.

When speaking of inflammation of various parts, I took notice of the pulse peculiar to each part, which I may now be allowed to repeat. First, I observed in inflammation of parts not vital, or such as the stomach did not sympathize with, that if there was great power and not much irritability, the pulse was full, frequent, and hard. Secondly, on the contrary, in inflammations of the same parts, if the constitution was weak, irritable, &c., that then the pulse was small, frequent and hard, although, perhaps, not so much so as when, thirdly, the inflammation is in a vital part, as the stomach or intestines, or some part with which the stomach readily sympathizes ; then the pulse is quick, small, and hard.

Now in the first of these dispositions bleeding is absolutely necessary ; but in the second, where the pulse is small and frequent, bleeding should be performed with great caution : though the person may be of strong constitution, yet in inflammations of these parts the constitution appears to be more irritable, and to have a greater sense of weakness. We should bleed to two or three ounces by way of trial, which could do no harm.

The urine will throw some light on the disease ; if high-coloured, and not much in quantity, it may be presumed, with the other symptoms, that bleeding will be of singular service ; but if pale and copious, though the other indications may be strong for bleeding, it may be necessary to do it with caution.

Bleeding, however, is a remedy of so much importance that it should be employed in all cases with great caution ; yet not more than appears really necessary.

I cannot perceive why bleeding should have such an effect on inflammation as it often has. We cannot account for it simply on the mechanical principle of lessening the quantity of blood, because this can never remove the *cause* of inflammation.

Medicines.—Medicines which have the power of producing sickness lessen the powers of life universally, because every part of the body sympathizes with the stomach ; and when they are intended to produce this effect they should not be given in doses sufficient to produce anything more than sickness, for the act of vomiting is rather a counteraction to that effect, and I believe has rather the effect of rousing, as few are so weak as not to be able to bear sickness. Purges have been much recommended, under the idea that there were humours to be carried off ; such practice answers best

in the cases in which bleeding is useful. In irritable habits, where inflammation becomes more diffused, greater caution is necessary, as nothing tends to weaken the habit more. A single purge has been known to produce death in dropsy. In such cases bark may be required to bring the constitution into a proper state, either for resolution or suppuration, by increasing the powers and diminishing the action; and thebaica may be a good assistant as a soother or sedative with the bark.

Modes of Resolution by external applications—Whether we have any external applications which have really a tendency to resolve an inflammatory disposition, is not well ascertained. We are in possession of many that can weaken, so as to lessen the powers (most of which appear to be of the soothing kind), and thus lessen the action, though the cause may still exist; by which means the effects are lessened, and the inflammation is either cured or protracted, until the disposition wears itself out. Perhaps cold is one of the greatest weakeners, but it should not be used too freely, as it may produce a worse disease, which is indolence. Lead is supposed to have considerable effects in this way; but I believe much more is ascribed to it than it deserves. Its properties appear to be to lessen the powers, and therefore it should not be used except when the powers are too strong. Applications to weaken should not be applied to irritable parts; on the contrary, the parts should be strengthened, which can only be done through the constitution.

Whatever power external applications possess, they must act in one of four ways: first, which is the immediate or truly local; second, by repulsion; third, by revulsion and derivation; fourth, by sympathy, which is probably the same principle in the animal economy as revulsion and derivation.

The first, or local effect, may be of two kinds: 1st, simply such as is an antidote to the action of the part, as cold, sedatives; 2d, such as destroys the first irritation, by exciting a second. This is most applicable to specific diseases, as the action of mercury in a venereal sore: but all specific diseases will not allow of it; a gonorrhœa in a scrofulous habit is an instance of this. In some cutaneous affections this mode of cure is very useful. Sedatives are less useful as local applications than counter-irritants, but both of them may have another effect, viz., repulsion or derivation, which must be from a constitutional affection, such as I have called an act of the constitution, as in gout. If the constitution is determined to have a local complaint, by which she throws off a constitutional disposition, then these revulsions do not rid the constitution of the disposition. It is difficult to say what will merely repel and what will cure. Repulsion, however, is a cure of the part, whatever effect it may have on the constitution. Surgeons were formerly greatly afraid respecting repulsion. They were even afraid of curing a gonorrhœa, lest they should drive it back into the constitution and produce a pox; but they did not consider that it does not arise from the constitution, and has nothing to do with it.

Revulsion and derivation appear to me to depend on the same principle in the constitution as sympathy, and, like the latter, have the greatest effect in habits which are irritable or nervous, and in diseases which are nervous, as cramp; not in such as change the structure of parts. I knew a nervous girl cured of pain in one arm by rubbing the other. These terms were used under the idea of removing humours by inviting them from other parts, as making an issue to remove eruptions. They probably act by causing an irritation in one part to cease when an irritation in another is excited; and this latter may be made greater than the original one though in a part less dangerous, and where it can be more easily cured, as burning the ear cures the tooth-ache; vomiting, the swelled testicle; blisters, pleurisy, &c. In some of these, as the vomiting to cure the testicle, no new disease is excited, but only the action of the part. The cures performed by these modes are in many cases preferable to those by means of local applications, and they will succeed where the others fail; thus vomiting will cure hernia humoralis, when other applications have had no effect. The cure by revulsion, or sympathy, is in some respects the reverse of that by derivation, yet it is probably from the same consent of parts, but from a different action. In these a remedy is applied to a sound part to cure a diseased, which is either contiguous, continuous, or remote, and the action is either similar or dissimilar. The cure of continuous parts by similar sympathy is by the application of such remedies as we suppose would cure if applied to the part. That of remote parts by dissimilar modes of action, is by stimulating a part in such a way as that the sympathy shall act in the same way, and yet the action in the diseased part be not at all similar to that in the sound part: suppose, for instance, a part in any mode of action, a medicine applied to it would increase that action, but by applying it to another part it will remove the first. The contiguous is different from the two former, and can only be applied to surfaces, as a blister to the scalp to remove headache. These may be either stimulating or soothing, or specific.

Treatment of adhesive Inflammation when Suppuration must take place.—The treatment must, in some measure, be the same as in the foregoing in accidents where the powers are very great, and the inflammation violent, namely, bleeding, purging, sickness, &c.; but when the constitution is irritable, bark, &c., as before directed. In cases where there is considerable sympathy, sudorifics, as Dover's powder, seem desirable, as they tend to keep up the harmony between the skin and the stomach. Opium in peculiar constitutions increases irritability; but in others, where there is not this peculiarity, it is highly useful in soothing and diminishing irritability.

Different applications have been made to the inflamed parts, as fomentation, washes, poultices, &c. The mode of applying heat and moisture by fomentation appears more efficacious than in the form of a fluid; it certainly gives ease at the time of the application, but the symptoms generally recur between the times of using it, and with nearly the same violence. How far the application of a

medicine for fifteen minutes out of the twenty-four hours does good I hardly know.

Washes are fluid applications, and are more commonly used to inflamed internal surfaces than to the common integuments. I am afraid we are not much acquainted with their true specific virtues, the use of them being very vague. For inflammation of the eyes we use astringents, as alum, vitriol, &c. For inflammations of the throat we gargle with port wine, vinegar, &c.; yet how absurd it would be, in the opinion of any surgeon, to use the latter applications to the eyes; and yet if the two inflammations are the same I do not see why we should not use the same remedies to both parts. These, like the former, have only temporary effects.

Poultices are constant applications, and may be either simple or medicated; their effect is greatest locally, but it extends likewise to surrounding parts, by sympathy. They may be medicated with lead, opium, &c. Simple poultices are the best application where we have no particular object in view.

CHAPTER XIV.

OF SUPPURATIVE AND ULCERATIVE INFLAMMATION; GRANULATION, SKINNING, HECTIC FEVER, AND DISSOLUTION.

Suppurative inflammation;—difficulty of tracing the chain of causes leading to it;—not arising from the access of air;—nor from external violence;—occurs most readily in canals.—Peculiar pain attending it;—rigor;—diminution of the inflammation.—Cure of suppurated parts;—abstraction of matter by absorption, or by external opening;—granulation;—cicatrization.—Of pus;—its formation;—gradual changes from lymph to pus;—breach of substance not necessary to its existence;—erroneous notions of its formation and uses.—Of absorption of the whole or parts of the body, in consequence of disease.—Interstitial and progressive absorption.—Interstitial of two kinds;—1st, wasting;—2d, complete removal.—Importance of the latter;—and of progressive absorption.—The two sometimes mixed.—New parts most subject to be removed.—Causes which render parts liable to absorption.—Relaxing process of the skin over an abscess.—Absorption with or without suppuration;—Ulceration;—progressive and interstitial absorption combined;—almost always accompanied by inflammation;—seldom affects the constitution.—Whitlow.—Granulation;—not always attended with suppuration;—does not appear till abscess has been opened;—arises on one surface;—nature and structure of granulations;—colour an index of the state of the parts and constitution;—contraction of granulations;—followed by cicatrization;—an assistance to this process.—Of skinning.—New skin generally arising from old skin;—economy of nature in forming new skin.—Hectic;—when arising; causes numerous;—symptoms;—erroneous notion of cause.—Treatment;—incurable;—when from local disease in removeable parts, they are to be removed.—Dissolution, definition of the term;—when occurring;—symptoms;—incurable.

WHEN an inflammation exceeds the adhesive state, and has got beyond the power of resolution, and when the adhesive has set

bounds to the suppurative inflammation, the suppurative begins; or in internal surfaces, where the adhesive cannot take place, the suppurative begins. The irritation which is the immediate cause of suppuration is the same, from whatever cause it may have been produced: it is a similar process, going through the same stages, whether it takes its rise from external violence, or from the constitution, or from disposition for disease in a part, if all other circumstances are equal. It is very difficult to give a true and clear idea of the whole chain of causes which lead to suppuration. Irritation simply is not always sufficient; it often only brings on the adhesive inflammation. Violence done to a part is one of the great causes of suppuration, but this alone is not sufficient: it must be with a prevention of union by the first intention, or by adhesive inflammation; it must be attended with death in the part, as in bruises. The application of air to internal surfaces has generally been assigned as a cause of inflammation, when it happened in consequence of destruction of a part; but air has certainly no such effect, for a stimulus would arise from a wound were it even contained in a vacuum; nor does it get to the parts forming circumscribed abscesses, which yet suppurate, in consequence of inflammation, as readily as exposed surfaces. In many cases of emphysema, where the air is diffused over the whole body, we have no such effect, excepting there is produced an exposure of some internal surface for the air to make its escape by, and then the wound inflames. In birds we find the cells in their bones communicating with the lungs, so that they have at all times more or less air in them, although they never inflame; but if these are exposed by a wound, the stimulus of imperfection is given, and inflammation begins, and suppuration may succeed. The same observation is applicable to a wound made in the abdomen of a fowl, for there the wound inflames and unites the intestines, to make the cavity perfect again; but if the union is not allowed, to take place, more or less of the abdomen will inflame and suppurate. How should we account also for suppuration taking place in the nose during catarrh, since it is not more exposed to air then than at other times? Air, therefore, is not the cause of suppuration.

We are at a loss to say, with regard to spontaneous inflammation, whether it is a disease in which the constitution will be injured, or whether it is a salutary process in which nature is endeavouring to relieve herself; and it is evident that the same action may arise from different causes.

Suppuration does not depend on the violence of the inflammation; for that circumstance, simply considered, rather tends to produce mortification; and we see that in gout, which does not suppurate, there often is more violent inflammation than in many other cases that do: and in true scrofula we have suppuration without any visible inflammation: so that this does not seem essential to suppuration. Although we find that inflammation and suppuration from injury are very violent, yet that which occurs spontaneously generally

exceeds it in violence. In inflammations of the breasts in women and of the testicles in men, the quicker the inflammation proceeds the better; for where it is slow it gives the idea of specific inflammation, as this generally proceeds slower than simple inflammation.

Suppuration takes place more readily from the surface of canals than in either the cellular or investing membranes; the same degree of inflammation which will produce suppurative in the first mentioned parts will only produce adhesive in the latter. If a bougie be introduced into the urethra, it may produce suppuration; but if introduced into the tunica vaginalis or abdomen, it will only give a disposition for adhesions.

Symptoms of suppurative inflammation.—The sensations arising from a disease generally convey some idea of its nature. Some diseases give what is called a heavy, a dull, or a gnawing pain, &c.: but the suppurative inflammation gives as much as possible the idea of simple pain, without having relation to any other mode of sensation; this pain is increased at the time of the dilatation of the arteries with the sensation called throbbing. The part now becomes more swelled by the greater dilatation of the vessels and a greater quantity of extravasated fluid being poured out, and the scarlet colour increases from the admission of red globules into vessels, not naturally conveying them, and the formation of new vessels, and an cedematous appearance, like that in erysipelas, takes place. One, two, or three parts of the inflammation lose the power of resolution, and take on exactly the same disposition with that of exposed surfaces, or a surface in contact with an extraneous body. If it is in the cellular membrane that this disposition takes place, or in the investing membrane of circumscribed cavities, the vessels now begin to alter their disposition and mode of action, and continue changing till they bring themselves to that state which fits them to form matter. But as this change does not take place all at once, some parts may for some time continue to discharge coagulable lymph, as in the adhesive state, whilst those parts which have taken on the suppurative action pour out matter: and hence, if the tumour be now opened, it will be found to contain both matter and coagulable lymph: in which state it has always been imagined that the matter had not arrived at a state of ripeness by those who supposed its purulence to depend on its confinement and stay. It would appear, from matter forming from the investing membranes of internal cavities and from mucous surfaces, that matter may be formed without any breach of surface.

There is a certain period in inflammation when suppuration begins, and which is discovered by new symptoms, as shivering, &c.; and though the change is pretty quick, time must be allowed for the vessels to be fitted for the suppurative state. The effect of inflammation seems to be the producing the suppurative disposition, or that state of parts which disposes them to secrete pus: in doing this, inflammation seems to be carried to such a length as to destroy that state of parts on which itself depends; the consequence of which is that they lose the inflammatory and come into that disposition

which fits them for throwing out matter. That the suppurative is very different from the adhesive inflammation is plain from this, that if a wound in a suppurative state, yielding good matter, has by irritation of any kind the adhesive inflammation produced in it to any degree, the discharge lessens, and the wound puts on appearances very different from what it had before. It seems a fixed and useful law in the animal economy, that when inflammation has gone to the length of destroying the natural functions of parts, so as to prevent their returning by a retrograde motion to that state from which they set out, suppuration should come on to give them a disposition for a second mode of cure.

Treatment of Suppuration.—Suppuration may sometimes be removed by producing action in other parts: thus, I have seen a bubo cured by a vomit, and similar effects are producible on scrofulous tumours. When suppuration cannot be stopped or resolved, in most cases it is to be hurried on towards the skin, which generally is the first step taken by surgeons. How far suppuration can be increased by medicines or applications I do not know, but attempts are generally made; hence we have, I think, in the pharmacopœia, (though I do not read many books,) suppurating cataplasms, maturing, &c., but I doubt if they have considerable effect in this way, for the same applications applied to a sore would hardly increase the discharge of that sore. However, in cases where the parts are indolent, and hardly admit of suppuration, by stimulating the skin more salutary inflammation may be produced, and of course quicker suppuration; but with true suppuration, preceded by inflammation, it is I believe hardly necessary to do anything with respect to the suppuration itself. Nevertheless it has perhaps been found by experience that these applications tend to bring matter faster to the skin, even in the rapid suppurations; only, however, in those cases where the inner surface of the abscess is within the influence of the skin. This effect, too, may arise from another mode of action being produced than that of quicker suppuration, which is the hastening of an ulceration. Poultices of bread and milk are commonly used to inflamed parts when suppuration is known to have taken place: this application can have no effect, except that of lessening the inflammation, or rather making the skin easy.*

Of suppuration without inflammation.—I have hinted that thickening of parts took place sometimes without inflammation, and also that the suppurative inflammation might take place without being preceded by the adhesive. Many indolent tumours, slow swellings of the joints, swellings in the lymphatic glands, tubercles in the lungs, and swellings in many parts of the body, are of the first kind, namely, thickening without visible inflammation; and the contents

* [The immediate effects of poultices and fomentations to inflamed parts are, 1st, to soothe the pain and irritation; 2d, to augment the local perspiration; and, 3d, to diminish the tension. The addition of sedatives and narcotics certainly increases their soothing effects, and their continued application certainly promotes the suppurative process.]

of some kind of encysted tumours, the matter of many scrofulous suppurations, as in the lymphatic glands, and in the joints of the foot and hand, for instance, and in the hip-joint, called hip-cases, of the loins, called lumbar abscess, the suppuration of tubercles in the lungs and in many other parts of the body, all exhibit the formation of matter without any previous visible inflammation. They come on insensibly, the first symptom being a swelling in consequence of the thickening, (which is not the case in inflammation, for there sensation is the first symptom,) and this swelling is increased by the formation of matter.*

The nature of the matter is another distinguishing mark between suppuration in consequence of inflammation and that without it, the latter being generally composed of a curdly substance mixed with matter. The curdly matter is, we may suppose, the coagulable lymph deprived of serum, the thinner part is true pus, having the globules and specific properties of pus, and is often as thick as the common pus formed in consequence of inflammation.

All parts which form pus of any kind, whether in consequence of inflammation or otherwise, must go through similar processes to produce the ultimate effect or cure. The first step, in either case, is the evacuation of this matter, for till that is effected nature cannot take means towards a cure; the second step is granulation; the third, cicatrization.

There are three modes of doing the first; one is the absorption of matter, which is very common in the scrofulous kind, but not in those suppurations which are the consequences of inflammation, and which produces no alteration of the part except the gradually creeping into a sound state; the other modes of discharging this matter are, either opening the abscess, to allow it to pass out, or allowing ulceration to take place on the inside to produce its escape; which process, in the present case, having peculiarities different from those arising from inflammation, it is necessary to explain still further.

Ulceration in consequence of suppuration arising from inflammation, is very rapid, especially if the suppuration is very rapid; but ulceration in consequence of suppuration not the effect of inflammation, is extremely slow: it may remain months or even years before the parts give way.

When an abscess in consequence of inflammation is opened, it immediately proceeds towards a cure, and perhaps may have gone

* [Those singular deposits of purulent matter which occur in the joints, the serous cavities, the viscera, and the cellular membrane, during the progress of phlebitis and secondary inflammations, are examples of the same kind. I have, on several occasions, found all the principal joints of the body filled with an apparently healthy pus, although during life there were no symptoms of inflammation, nor after death any indications of increased vascularity.

The question, therefore arises, Does suppuration ever occur independently of inflammation? I think it does. The formation of cartilage antecedently to that of bone is a parallel case, and yet instances every now and then occur in which ossific depositions are formed independently of this condition.]

some steps towards a cure before the opening. As inflammation lessens, suppuration becomes still more perfect, granulations begin to form, &c. But when an abscess not preceded by the common inflammation is opened, a very different process is first to take place; the consequence is, that inflammation now takes place over the whole cavity of the abscess, which afterwards produces perfect matter, like that produced when inflammation is the original disease. However, it sometimes happens that they inflame before they are opened, in consequence of the matter distending the cavity acting like an extraneous body, not in consequence of the cause of suppuration. I have seen white swellings of the knee inflame before they were opened, then ulceration took place, and the pus was brought soon to the skin, though before it had been for months without producing the least tendency to ulceration, and of course none to inflammation; but the confinement of matter became the cause of inflammation. The inflammation and new suppuration taking place in consequence of an opening into these abscesses, is exactly similar to those inflammations and suppurations which take place in consequence of an opening made into internal cavities; and it is extraordinary that often upon opening these swellings, inflammation, fever, nay death, shall follow, but if suffered to break of themselves no such effect is produced.

Of Pus.—The immediate effect of the modes of action above described is the formation of matter commonly termed pus. This matter is very different from what was discharged during the adhesive stage of inflammation, and also very different from the common secretion of internal canals: yet when these surfaces form pus it is probable they are formed by the same vessels; if so, their mode of action must be greatly altered.

In suppuration of the cellular membrane or of circumscribed cavities their vessels are but little changed at the commencement of the suppurative disposition, so that they still retain much of the form they acquired by the first stage. The discharge is at the beginning little more than coagulable lymph mixed with some serum; this is scarce different from the discharge in the adhesive stage of the inflammations; but as the inflammatory disposition subsides, a new disposition is every instant altering these vessels to the suppurative stage; the discharge is also varying constantly from a species of extravasation to the new-formed matter peculiar to suppuration. The matter removes further and further from the nature of blood, losing the yellowish or greenish hue, and becoming white, and more viscid and creamy. By the formation of this new substance, the coagulable lymph, which was extravasated in the adhesive state, and adhered to the sides of the cells, either on cut surfaces, as wounds, or on the walls of abscesses, is pushed off, and if there is a cavity, is pushed into it, so that we should find in the cavity both coagulable lymph and pus; or, if on a cut surface, it is thrown off, and is generally removed, along with extravasated blood, &c., with the dressings.

This is the process which takes place in the first formation of pus in an abscess, or from the surface of fresh wounds.

On the internal surface of canals the parts are not obliged to go through all these steps; they run into suppuration almost instantaneously.

Mode of Formation of Pus.—Pus is formed by some change, decomposition, or separation which the blood undergoes in its passage out of the vessels. To carry on this process, either a new and peculiar structure of vessels must be formed, or a new disposition or mode of action of the old must take place. This new structure of vessels, or new disposition of vessels, I shall call glandular, and consider pus as a secretion.*

Dissolution of the living solids of an animal body into pus, and that the pus already formed has a power of occasioning their further dissolution, is an old opinion, and is still the opinion of many.

But if this idea were just, no sore which discharges matter would be exempted from continual dissolution; and I think it must appear inconsistent that matter which was probably intended for salutary purposes should be a means of destroying the very parts which produced it.

The circumstance of internal circumscribed cavities, as the abdomen, thorax, &c., forming pus, and where they might often have seen pints of matter, without any breach in the solids to produce it, (which is proved beyond controversy to take place,) should have taught them better; and the prevalence of this idea certainly shows a barrenness of knowledge and observation. Such an idea might be forgiven when it was thought that the discharge in gonorrhœa arose from an ulcer; but now that it is known that there is no ulcer in the urethra, it can only continue from mere stupidity.

The moderns have been more ridiculous still: they have put dead matter into pus, and have thought that it has been formed into pus, and have thence inferred opinions similar with the former. In this case they have been putting dead and living animal matter on the same footing. But what is still further, they might have seen that extraneous matter cannot be formed into pus, by observing that in wounds, and in suppuration with extravasation, blood and pus are found separately in the same cavity, and that in extravasation of blood in sound parts no pus is produced. In abscesses from violence and erysipelas they might have seen sloughs of dead cellular membrane, hanging like wet tow, and not melting down into pus, although exposed to the action of matter for a long time. The same observation holds good with regard to dead bones, when exposed to the action of pus; besides, if, in consequence of the decomposition of

* [Delpach endeavoured to prove that pus was always secreted by a new membrane (*membrane puogénique*) developed by inflammation; an opinion which received some colour of support from the appearance of cysts in old abscesses. Nothing, however, is more common than to see suppuration from mucous and serous surfaces, where no trace of any such membrane is discoverable.]

these parts, some of their parts are mixed with pus, it is altered in its properties, thereby attaining a very ill smell. But if there is loss of substance in a dead piece of bone, for instance, it is produced by absorption; in proof of which we see that the loss is on that side where it unites to the sound parts, and where alone the absorbents can act.

The chemists found no difficulty in explaining the formation of pus, and this they supposed took place by fermentation. But fermentation necessarily implies that there should be something to ferment; and, according to this idea, there are three effects which contradict the notion of fermentation flatly. First, internal canals, where mucus only was formed, take on the formation of pus without previous loss of substance or previous fermentation, and they leave off the action in the same way. Secondly, internal cavities take it on without loss of substance. Thirdly, abscesses already formed leave it off. If fermentation was the cause in the first, what solids enter into the matter discharged? for the whole penis could not afford matter enough to form the matter discharged in a gonorrhœa. And how or by what power was the fermentation commenced? and how should it ever cease? for there is the same surface secreting its mucus whenever the fermentation of pus ceases? In the second case, what solids were destroyed when fermentation began? by what power is the first particle of this fluid formed in an abscess or sore, before anything exists capable of dissolving solids? And according to the third, an abscess shall form matter, become stationary, perhaps for months, and at last be absorbed; and what becomes of the ferment during the time it remained stationary?

We may safely, then, discard these notions, and say that pus is formed from the fluids alone, by the action of the living solids.

Pus appears to consist, when examined by the microscope, of globular bodies, such as compose cream;* these may be white, or not so, as we find glass appears white when powdered, though not really so. The globules swim in serum, or a fluid like serum, and most probably there is a little coagulable lymph mixed with it. The proportion that those white globules bear to the other parts depends on the health of the parts which form it; and when in larger proportion, the matter is thicker and whiter, and is called good pus, that is, the

* [These bodies were found by Dr. Hodgkin to be irregular in size and figure, and to have no resemblance to those of the blood; from which Dr. Babington has inferred the probability that pus consists merely of lymph, in a minute state of division, suspended in serum. The existence of globules gives to this fluid an iridescent appearance when viewed between two plates of glass, which was proposed by the late Dr. Young as a test of the presence of this matter in doubtful cases, and is still considered the best which we possess. Another test, derived from the facility with which pus is diffused through water, and afterwards subsides, is applicable to a great many cases, and is much to be preferred to any of those which depend on the reaction of chemical agents. The fact however is, that pus and mucus insensibly merge in one another, which renders the distinction between them *in transitu* impossible.]

solids that produced it are in health, for these appearances in matter are no more than the consequences of certain salutary processes, which are going on in the solids, the effect of which is to produce a disposition on which both suppuration and granulation depend.

Pus has a sweetish mawkish taste, as is known when it is formed in the mouth, and it coagulates by heat. This is the same, whether from an irritated natural surface, as the membrane of the nose and other outlets and canals, or from an ulcerated surface.

These discharges from canals or outlets have been termed mucus, and not pus; and the surfaces yielding these discharges have been termed mucous membranes. A test has been recommended for distinguishing these when their appearances have been so exactly similar as to afford no visible difference, and when, as I observe, they are in fact one and the same fluid. This test was the chemical solution of the fluid in menstrua, and its precipitation therefrom, a proposal which was unphilosophical on the very face of it, and which I treated from the first as absurd. I did conceive that all animal substances when in solution, either in acids or alkalies, were in the same state, and that the precipitation from them would be the same. But as it was so strongly asserted, and supported by experiments said to have been made, I, to satisfy myself, made several experiments with animal matter, both solid and fluid; these I dissolved in different acids, vitriolic, muriatic, &c., and made precipitates with several alkalies, both fixed and volatile, but all these precipitates appeared the same, even when examined with the microscope, exhibiting universally a flaky appearance.

The quality of the matter always depends on the nature of the part secreting it: whatever specific quality the part is affected with, the pus will possess the same; hence we have venereal matter from venereal sores, cancerous matter from cancerous sores, &c.; but though it takes on these qualities when the part yielding it is so affected, yet it does not derive these qualities from the constitution if it is so affected, unless that part is also affected. A circumstance which serves to show that the part which yields it is of the same nature with the matter produced, is that it does not prove an irritator to the surface yielding it, though it may to another; hence no suppurating surface can be kept up by its own matter. The gonorrhœa, small-pox, &c., curing themselves is a proof of this, for were not this the case we should have constant pain from the irritation and much more difficulty in the cure. We do, indeed, sometimes find that pus will irritate its own surface; but this may be the effect of some extraneous matter, as blood, &c., in the pus; the intestines will sometimes produce a discharge which stimulates them very considerably; but this may be secreted by the diseased surface, and prove an irritator to the sound part of the canal only. What I have hitherto said refers to natural pus only; but when a specific nature is added, then the secretion is altered. The first alteration is a greater quantity of serum and salts, producing a thinner discharge, called sanies; this discharge has sometimes

appeared to affect the solids, and has thence been called corrosive, a property which it does not possess,* the parts only receding from the irritation; and where this is the case, perhaps, the decomposition and new combination necessary to the formation of pus is not perfect, in consequence of the vessels having lost that structure which is proper for the secretion of pus; and this is probably the case, as healthy granulations are not produced when such matter is secreted. By what particular organization matter is produced we can no more determine than we can the nature of any other glandular organization.

Pus appears to have a greater tendency to putrescency than the other secretions have, but I do not think this is in the degree that has been supposed. It is brought into a putrescent state by circumstances independently of the pus itself. If the air is admitted to it by a small opening in an abscess, or it is placed near the intestinal fæces, or some parts of the solids which have sloughed, then it will be fetid; or if any dead blood, as in recent sores, is mixed with it, it is fetid; but if perfectly confined in an abscess it is always sweet, and will be a long time in putrefying. In erysipelatous inflammation, however, where there is an internal inflammation, there will be putrefaction; but this is probably from the solids themselves first putrefying. Hence we find, in most cases of specific disease, that the pus is offensive, because blood is mixed with it. Where there is dead bone also pus becomes very offensive.

The final intention of this secretion of matter is not, I believe, yet understood. Some say it is carrying off humours from the constitution, or that it is a constitutional disease changed into a local one, and so discharged, or thrown out of the body, either in the form of pus, or with it, as in those cases called critical abscess. Or it is presumed to carry off local complaints from other parts, by way of derivation or revulsion; hence sores or issues are made in sound parts to allow other sores to be dried up. But I am apt to believe that we are not yet well, or at all, perhaps, acquainted with its uses. We might naturally suspect that it was on the surfaces of sores to keep them moist, but this will not account for its formation on internal surfaces.

Absorption of whole parts in consequence of Disease.—The immediate effects of absorption of the body in consequence of disease may be said to be of two kinds. The first is only a wasting of a part, or the whole, without any breach in the structure or form, and

* [Pus very often corrodes the external parts. There seems also the greatest reason for believing that the presence of pus is highly deleterious in several forms of inflammation, as carbuncle, diffuse cellular inflammation, erysipelas œdematodes, inflammation arising from the bite of vipers, &c. Unless free and early openings are made in these cases, the inflammation or gangrene extends, apparently from the infiltration of pus, or that diseased secretion which precedes the formation of pus into the unadherent cellular membrane. That the pus, under such circumstances, acquires a highly poisonous quality, is proved by the effects which it produces on the constitution when injected into the veins. (See p. 136, note.)]

this I call the interstitial absorption; the second consists of the total removal of a part, as if by art, and this is the progressive absorption. The interstitial absorption may be considered in two lights; 1st, where it leaves the part affected still a whole, though wasted; 3d, where it entirely removes it, which latter resembles the natural process by which useless parts are removed, as the thymus gland, the membrana pupillaris, &c.

The process of removing entire parts of the body, either by the second interstitial or the progressive absorption, answers very material purposes in the machine. It is by means of the progressive that bones exfoliate and sloughs separate, that pus is brought to the skin, and that while new bones are formed old ones are removed; and although in these cases the process arises from disease, yet it is somewhat similar to the modelling process in the natural formation of bone. It is this last that removes useless parts, as the alveolar processes when the teeth drop out, or when children are shedding teeth, which allows these to drop out; and it is by these means that ulcers are formed. It is in many cases a substitute for mortification (which is another mode of loss of substance), for it is a degree of strength or vigour superior to that where mortification takes place; and in many cases it finishes what mortification has begun, by separating the mortified part.

The progressive is that absorption which begins at one side of a part to be removed, and goes on until the whole is removed, as in spreading ulcers.

These two modes, the interstitial and progressive, are generally going on at once, which may be called the mixed. This operation of absorption, like many other processes arising from disease, would often appear to be doing mischief, by destroying parts which are of service, and where no visible good appears to arise from it, as in those cases where the external covering is destroyed by ulcers or sores; but in all cases it must be reduced to necessity, for we may depend upon it that those parts have not the power of support, and it becomes a substitute for mortification. In many cases we shall see both ulceration and mortification going on, ulceration removing those parts which have power to resist death.

New-formed parts, or such as cannot be said to form a part of the original animal, admit more readily of removal than those parts originally formed: probably this arises from the principle of weakness. It is on this principle that all adventitious new matter is more readily absorbed than that matter which forms the substance of old tumours.

Remote Causes of Absorption.—The remote causes of absorption are various. The most simple appears to arise from a part's becoming useless, as the thymus gland, the ductus arteriosus, the alveoli after the teeth drop out, the crystalline lens after couching, the fat of the body in fever, either inflammatory or hectic, all which are removed by the absorbents as useless parts. Another cause is want of power in the part to support itself under certain irritations, which

may be considered as the basis of every cause of removal of whole parts, as calluses, cicatrices; also of parts pressed on. From all which it would appear that parts are liable to be absorbed from five causes: first, parts pressed on; second, parts considerably irritated by an irritating substance; third, parts weakened; fourth, parts rendered useless; fifth, parts become dead. The two first appear to me to produce the same irritation; the third, an irritation of its own kind; and the fourth and fifth may be somewhat similar.

Immediate Causes of Absorption.—The immediate causes of absorption of the body itself must be of two kinds respecting the parts, one passive, the other active. The first of these is a consciousness in the parts to be absorbed of the unfitness or impossibility of remaining under such circumstances, the action excited by the irritation being incompatible with the natural actions and existence of the parts, whatever these are; therefore they become ready for removal, or accept of it with ease. The second is a consciousness in the absorbents of such a state of part; and both concurring to do the same thing, they fall to work. When the part to be absorbed is a dead part, or extraneous matter, the whole disposition is in the absorbents. Pressure from without rather stimulates than irritates, for we find it produces thickening of parts; but if it exceeds the stimulus of thickening, it becomes an irritator. If pressure is from within, parts rather appear to give way, and absorption takes place.

Interstitial Absorption.—This is of two kinds with respect to the effects, or, rather, has two states. The first, where it takes place only in part, as in the wasting of a limb, where disease of the joint has rendered it useless; in a broken tendon; a divided nerve going to a voluntary part; or when it takes place in the whole body in consequence of disease, as atrophy, fever, &c. The second, when entire absorption takes place, and no vestige is left; and this would seem to be of two kinds, one where it takes place only in consequence of another disease, and is a necessary and useful effect of that disease, assisting in bringing parts to the surface, &c.; but the other appears to arise from disease in the part itself, as a total decay of the alveoli without any disease in the teeth or gums, as also the wasting of the testicle. The first of our second division of absorption of entire parts is taking place in a thousand instances; it is gradually taking place in that part of the body between many encysted tumours and the surface, and is generally slow in its progress.

Progressive Absorption.—The removal of those surfaces immediately contiguous to the irritating cause, which is an absorption of necessity, is effected by progressive absorption. Absorption from pressure is the removal of the part pressed, which may either be the surface of an abscess in contact with pus, or of that part of the surface of the body in contact with some body constantly pressing, as the buttocks or hips of those who lie long on their backs.

Of the Relaxing Process.—Besides the modes of removing parts above mentioned, there is another process, called the relaxing or elongating process, carried on between the abscess and skin. It is possible that this process may arise in some degree from the absorption of interior parts; but there is certainly some other cause, for the skin which covers an abscess is certainly looser than it would be from mere stretching; and it is very beautiful to observe how nature goes on in her own way to produce an effect. In consequence of the pressure of pus in an abscess, Nature sets up three processes to let it out; first, progressive absorption; secondly, interstitial, by which the progressive is assisted; thirdly, the relaxing process, making the parts yield to distension. In women, the relaxation of parts is very considerable before the birth of a child: and the old women in the country know when a hen is going to lay, by the relaxation and softness of those parts. The following cases exemplify those processes of absorption.

A lady, after inflammation of some of the abdominal viscera, had the belly swell; some time after, a kind of pointing was observed in various parts of the belly, and on opening the largest a very considerable quantity of fluid (matter, I think,) was discharged; this opening was near the sternum, and the ends of the recti muscles were quite ragged. The patient died. Here was an instance of the effects of absorption, by which an exit was obtained for the matter. Suppose an abscess to go on for a long time with a smooth surface, yet if any part takes on the absorbing process the matter will be very rapid in arriving at the skin, although this process may have taken place in the thickest part. This process may be induced by an irritation in any part of the surface; thus, after opening an abscess, if matter is permitted to collect at the most depending part, it may bring on this process, whence a fresh opening will be made.

This preparation [*showing one*] represents the front of a chest, which contained an aneurism of the aorta; and here on the right side you see an instance of the elongating process, the cartilages being bent outwards, or elongated, to adapt themselves to its figure.

This is another preparation (see Pl. III. f. 1.),—an aneurism of the aorta. AA, ends of the aorta; B, the first sac, which contracted at C, and having proceeded to *d*, where it met with resistance from the sternum DD, it became again contracted; but having produced absorption of the sternum *d*, E, by which an opening is made externally, the sac is again expanded. Here are two other preparations, exhibiting similar appearances.

Ulceration.

Before I enter on this subject I shall make a few more general observations on absorption.

Some parts of our solids are more susceptible of being absorbed, especially by ulceration, than others under the same or similar circumstances. This is particularly the case with cellular and adipose membrane, as we often find muscles, tendons, and ligaments deprived of their connecting membrane by ulceration, as may be observed in the opening of large abscesses. The skin itself, if affected by pressure from without, is less easily absorbed than the cellular membrane; hence we may observe, that in continued pressure from without the skin will remain whole, although the parts beneath are wasted by the absorption of the cellular membrane; but sometimes the skin is more susceptible of absorption than the cellular membrane; this may proceed from the skin acting with so much more vigour, either in opposing any injury or in taking on salutary action. Although in abscesses, in tumours, and in the case of extraneous bodies, the parts all round are equally pressed, yet we find that the progressive absorption takes place only on that side nearest the skin, and arrives at the skin only on that side: a very slight degree of pressure from within will produce this effect, so slight as would from without have produced only a thickening of parts.

Bones are susceptible of a similar process. Absorption may be of two kinds,—without suppuration, or with it. The first, I believe, is universally the case with the interstitial absorption when it takes place alone, as in the absorption of callus, of the alveoli of the teeth, &c.; but the second may precede or produce suppuration where there was none before, as in old sores breaking out anew. To distinguish the second from all other modes of absorption of whole parts, I shall call that absorption ulceration which is either preceded, accompanied, or succeeded by suppuration. Absorption may be a consequence of pressure under two circumstances,—where the pressure is from diseased parts, or from extraneous substances. Of the first is that from tumours, &c.; thus, in a case of aneurism, where the coats of the artery press against the bones, the rib for instance, its coats begin to be absorbed, and, after they are absorbed, that absorption goes on in the bone, the adhesive inflammation takes place at the same time round it, and unites the circumference of the absorbed parts: another instance is where tumours make their way to the skin, without any suppuration taking place. Of this I once saw a very remarkable instance in a soldier in the Dutch service: a tumour had formed between the pia mater and dura mater, which gradually increased to a very considerable size, and had shown itself externally some time before the man died. Upon examination after death I discovered that the pia mater was absorbed underneath it; but the chief absorption had taken place on the side next the skin, for on this side the skull was absorbed, and the absorption had begun in the integuments of the scalp, which it would soon have probably ulcerated had not the man died before Nature had finished her operations; and in this case no matter was found either on the brain, skull, or in the integuments, owing, perhaps, to the pressure being made by a living part. This

species of absorption is attended with very little or no pain, and its effects are as trifling on the constitution, although it may be an effect of an alteration in the constitution, as the absorption of calluses in scurvy, &c.

Ulceration.—I shall now take notice of that action of the absorbent system which I call ulceration, and which is the second species of our first division, being connected with the formation of pus, either as a consequence or as a cause; and it is this kind which always constitutes an ulcer.

This process of ulceration or absorption with suppuration, is almost constantly attended with inflammation, which led me to call it ulcerative inflammation. Ulceration is generally attended with considerable pain, which is called soreness; but this does not attend all ulcerations, for there are some which are of the specific kind, which give little or no pain, as scrofula; but even in this disease, where ulceration proceeds pretty fast, it often gives considerable pain, wherefore the pain may be in some degree in proportion to the quickness of its operation. In those cases where ulceration is set up to separate dead parts, as sloughs, it is seldom attended with pain, and it is not easy to assign the cause of this.

It seldom or never affects the constitution much, although the process is affected by the constitution.

What I have hitherto said of ulceration I shall illustrate by noticing what occurs in an inflammation of the peritoneal coat of an intestine. The first inflammation produced is the adhesive, which occasions an adhesion between the inflamed part of an intestine and the peritoneum lining the cavity, which remains, although the inflammation should stop here; but if it does not stop here, then the suppurative takes place, and an abscess is produced, the matter of which is collected into a regular cavity in these adhesions, and is prevented from diffusion through the cavity of the abdomen by the effects on the surrounding parts, by the preceding adhesive inflammation, as well as of that which accompanies it. This matter, by its pressure, irritates, and absorption takes place in consequence; but as none of the parts, except those between the matter and the skin, are hardly, if at all, susceptible of this irritation, no parts are absorbed but such as are so situated: hence the abdominal muscles, cellular membrane, fat, and skin are removed in preference to the coat of the intestine. If the suppuration had at first begun in different points, the parts between are absorbed until it becomes one abscess; and when it reaches the skin we have the ulcerative inflammation. It is in the same manner that Nature acts in all abscesses of circumscribed cavities, as in common abscess, inflammation of the lung of the side next the pleura, of the pleura itself, gall-bladder, liver, &c.; also in the case of lumbar abscesses. In the substance of the lungs we sometimes find abscesses go on in a different manner, and open into the cells, and this because the adhesive inflammation finds it difficult to connect the air-cells together; and that the air-cells do not take on the adhesive inflammation is evident

from many observations. Whilst a part is under the ulcerative inflammation, irritation will increase the absorption on any part of its surface. Thus, if a large abscess forms on the thigh, opposite the great trochanter, we shall find that, from the pressure of the trochanter on the part opposite to it, ulceration will take place there likewise. An irritation we have of the same kind in milk abscesses, from the irritation of the matter in a depending part of the abscess, which shows how very easily, from the slight pressure of matter, the ulcerative process may be produced. Ulceration is, therefore, no more than a process by which parts are removed out of the way of pressure. The ulcerative process has no effect on the cuticle; but in general this is so thin as not to give any trouble, as it easily bursts. But on the fingers and hands of working people it becomes so thickened as to cause excessive pain and trouble in whitloes; and as from this cause we have so considerable a separation between the cuticle and the skin, these abscesses should be opened early. Poultices in these cases are more useful than in any other, for their moisture is absorbed by the cuticle as by a sponge, and the cuticle is rendered more dilatable. After these have been opened, or have opened of themselves, by a small orifice, the soft parts lying under are apt to push through the opening, and appear like a fungus, occasioning great pain, which is owing to the cuticle around the granulations underneath. To this escharotics have been applied; but it would appear that there is no necessity for them, as it would disappear of itself when the thickening of the parts in consequence of inflammation has gone off. But besides ulceration, the consequence of previous suppuration, which we have been hitherto describing, we have ulceration taking place where no reason can be assigned for it, except perhaps weakness be the cause, the parts not being able to support themselves. New parts are more susceptible of it than old, as cicatrices, stumps, calluses, &c. This arises from the new parts being less firm than the old original ones, as in Anson's voyage, when there was a general debility from the change of climate, &c. The appearances of ulceration are different at different times, according as the process is going on, at a stand, or the parts healing. The ulceration in the small-pox is attended with death in the parts, hence loss of substance and pitting.

Restoration of Parts.—We are now to trace the operations of Nature to bring parts back as near to their original formation as possible. These operations cannot be looked on as morbid, as they are for a salutary purpose.

Granulations.—These have, I believe, in general been supposed to be a consequence of, or an attendant on, suppuration; but the formation of granulations is not confined to a breach of the solids allowed to suppurate, as from accident, or a breach of the solids, produced in consequence of suppuration, as in abscesses; but it takes place under other circumstances, and when the first and second bond of union have failed, as in simple fractures.

I believe no internal canal can granulate in consequence of suppuration, except there have been a breach of continuity. And here I may observe, that when granulation does take place in such a canal, it is not on the proper coat of the canal, but on the surrounding cellular membrane. Few surfaces of abscesses granulate until opened, either of themselves or by art; therefore in abscesses of very long standing we seldom or never find granulations.

In most abscesses, if not in all, after they are opened, there is one surface more disposed to granulate than the others, which is the surface next to the centre of the body in which suppuration takes place, the surface next to the skin hardly ever having the disposition to granulate; on the contrary, it is sometimes ulcerating when the bottom of an abscess is granulating. Exposure is so far necessary for granulations, even in cases where there is an opening, that if the opening is only a small one, and the abscess is deeply seated, the latter will not so readily granulate, which often becomes the consequence of deep-seated abscesses not healing.

I have said that granulations are not confined to a breach of the solids attended with suppuration; for parts are capable of making new matter internally in cases where union by the first intention ought to have occurred. A case in St. George's Hospital first gave me this idea.

I was called to a man with a fractured thigh, and made use of the usual means, but without success, for no union of the fractured parts was formed in the usual time; and about the end of four weeks the man died with another complaint. Upon examination of the parts, I found that the upper end of the bone rose considerably over the under, and consequently there was a great cavity in the soft parts, the parietes of which were thickened by the adhesive inflammation, though not so much as if the parts had been better disposed for the adhesive inflammation. There was no extravasated blood, nor matter, nor coagulable lymph to be found, except a few threads, which were probably the remains of extravasated blood. Here the parts had lost two chances of being united, the one by the extravasated blood, the other by the coagulable lymph thrown out by the adhesive inflammation; and Nature had begun a third, which was that of forming granulations of new animal matter on the ends of the bone and the surface of the surrounding cavity; and adhesions, you see, had taken place between the bones and soft parts, by which the bones would have been united by a bony case. Hence we find that granulation may take place without the parts being exposed, and without suppuration.*

This mode of union by granulation is, I believe, much more

* [The effusion of callus in this case does not seem to differ essentially from the effusion of callus in other cases. It certainly cannot be regarded as a conclusive proof of the existence of granulations without suppuration and exposure, although these do sometimes continue to form after cicatrization, as in burns and some other cases.]

extensive than has been imagined; this third bond of union taking place where the parts have missed the first and second, as just mentioned. In the exposure of cavities of abscesses we have granulations going hand in hand with, and following suppuration. As the suppurative inflammation follows injuries with exposure, it seems that this inflammation is in general necessary to granulation in these cases.

Granulations are an accretion of new animal substance on the surface of a wound, or a newly-formed surface composed of coagulable lymph exuded from the vessels, into which new substance the old vessels probably extend, and entirely new ones are formed, so that the granulations come to be very vascular, more so indeed than any other particular animal substance. The vessels pass from the original parts to the base of the granulations, and from thence to their outer surface. The surface of this new formation continues to have the same disposition for the secretion of pus as the parts on which they are formed had; therefore it is easier to suppose that the nature of these vessels does not alter by forming granulations, but they are completely changed for this purpose before granulations are begun to be formed, and that these granulations are the consequence of the change. They always also are of the same nature with the parts on which they are formed: if a diseased part, they are diseased; if the disease be of any specific kind, they are of the same kind and produce similar matter. The surface of the granulations is convex, being just the reverse of an ulcerating surface, which is thus, as it were, shagreened by a great many points or small eminences: the smaller these points are, the more healthy the granulations. The colour of healthy granulations is a florid red, which would make us suspect that it is principally owing to arterial blood; when they are of a livid red they are most commonly unhealthy, and have a languid circulation in them; however, this appearance frequently is owing to the particular position of the parts. I knew an instance of this in a young man who had a granulating wound on his leg. I was surprised to see it on some days of a healthy scarlet, and on others quite livid; but the cause of this he explained to me, by showing that if he kept it in a recumbent posture for a short time, its surface was then of a bright scarlet, but if he stood for a few minutes it would become quite livid. This appearance must have arisen from the stagnation of blood in the newly-formed vessels, and from their not possessing sufficient strength to resist the superincumbent column of blood, which sufficiently accounts for the difficulty of healing sore legs when patients are allowed to stand or walk much.

Granulations not only show the state of the part on which they are formed, but also how far the constitution is affected in many cases. The chief of those which affect granulations are the irritable and indolent habits, and, still more, fevers, which must be of such a nature as to produce universal irritation in the constitution.

Granulations have a disposition to unite with one another, which

is absolutely necessary to healing; and this is done, I suppose, in the following manner: when two granulations meet, the mouths of the opposing vessels are irritated, which causes them to embrace each other; this junction perhaps being aided by the attraction of cohesion, or they may throw out coagulable lymph, and unite in that way. I have seen granulations from the dura mater and scalp unite so closely in twenty-four hours as to be with difficulty separated, and then to bleed very freely, which shows their great disposition to unite. When the parts, and consequently the granulations, are not sound, there is not this disposition to unite, and a smooth surface is formed, which continues to secrete pus. I conceive the internal surface of a fistulous sore to be of this nature, and somewhat similar to the urethra in gleet. Ulcers of this kind are cured by exciting inflammation in them.

Granulations have less powers and shorter lives than originally formed parts. Different animals have different periods of life, and so have granulations, and sometimes they seem to be formed with a short period of existence. They often die and slough off without any visible cause, and, coming down to the original parts, a fresh crop of granulations is formed, which in a certain time will again slough off without any apparent change in the constitution.

Many small wounds would perhaps do much better without any dressing. The blood, coagulating and drying, forms itself into a scab, which falls off and shows that Nature has completed her work under it; the same will often happen when small suppurating sores are suffered to dry. This is a circumstance not attended to, perhaps, as much as it ought: even compound fractures with a small opening, if suffered to proceed in this manner, will often give but little trouble. In blisters, where the cuticle is not removed, the process is exactly similar. It would be a great advantage to us to ascertain what sores require dressing, and what do not. I believe all cutaneous sores do best without dressing; excoriations and little pimples had best be left to themselves, for often when applications are made to any of these, a hundred little pimples will sprout up: when this is the case, I make it a general rule to desist from any application.

A young gentleman had a small pimple on his leg, to which a little ointment was applied, and in a day or two the surrounding parts were covered with similar pimples: these, being treated with similar applications, spread, until the whole leg was covered with them. When I was consulted, and asked what was to be done—"Nothing." "How is that?" "Can anything be easier?" I said; "do nothing to the leg." "Then the stocking will stick to it." "Let no stocking be worn: put the boy on a pair of trousers." The advice was taken, and the leg dried up and healed directly.

Cicatrization.—Immediately on the formation of granulations, cicatrization would seem to be in view; contraction is going on in every part, but principally from the edges to the centre, so that the sore becomes very small, without much new skin. This contrac-

tion is easiest effected on loose parts, but with difficulty when over bones, as on the scalp, shin-bone, &c., where the granulations cannot contract much. This observation should direct us, in operations on such parts, to leave as much skin as possible. This contraction continues until the whole is skinned over; but their greatest power, or at least their greatest effect, is at first. This contraction can be assisted by art, which shows there is a resistance; this is done by bandages, but these should be avoided at first, while there is inflammation, and until granulations are formed, otherwise they might prevent the granulations rising. Besides the contractile power of the granulations, there is a similar power in the surrounding edge of the cicatrized skin, which assists the power of the granulations, and is often greater than that of the granulations; this may be seen in sugar-loaf stumps, where the skin grows round and embraces the granulations like a ring, appearing to squeeze them out; but it is only in the new skin, the old being loose all round. This contractile power prevents the necessity for so much new skin, the surrounding old skin being drawn over the parts. The advantage of this is very evident, the original skin being more fit to live than the new, and less liable to ulceration. As the granulations contract, the old surrounding skin is stretched, and is probably elongated. If it is elongated, it must be so by the interstitial deposition of new matter.

Of Skinning.—When a sore begins to heal, the old skin, which had been inflamed, then becomes whitish, and especially near the edge: this is one of the first appearances of healing. The new skin is a very different substance with respect to texture from the granulations on which it is formed; but whether it is an addition of new matter, or a change in the surface of the granulations themselves, is not easily determined. We find new skin generally taking its rise from the surrounding old skin, as if elongated from it; but that is not always the case, for in very large old ulcers, where the edges of the old skin have but little tendency to contract, new skin forms in different parts of the ulcer, standing on the surface of the granulations like little islands. These little specks show that the ulcer is healing slowly, and it seldom or never takes place the first time a part is ulcerated; but the old surrounding skin assists by shooting towards the new. The granulations may perhaps acquire a disposition to skin from their being in the neighbourhood of the old skin, but it is plain they can take on this disposition without that assistance.

Skinning is a process in which Nature is always a great economist. We never find that new-formed skin is so large as the sore was on which it was formed. This is brought about by the contraction of the granulations, which in some measure is in proportion to the quantity of the surrounding old skin. If a sore be in a part where the surrounding skin is loose, as the scrotum, the contractile power of the granulations being not at all prevented, very little new

skin is formed; whereas if the sore is on a part where the skin is tight, as the scalp, the new skin is nearly as large as the sore.

Nature of the newly-formed Cutis.—When granulations are formed near a bone, the skin is at first fixed; but it gradually becomes loose, from elongation, by continued attempts at motion. Motion given to the part so affected must be mechanical, but it becomes a stimulus by which the parts become conscious of their not being able to exist as they are, therefore the lymphatics set to work to absorb all the adventitious substances which prevent their motion. Medicine has not as much power as we could wish in assisting this process; however, mercury seems to have nearly the same effect as motion, especially when combined with camphor, and should be used. When everything else fails, electricity may be tried, for it has restored the motion of parts after they have been fixed from inflammations after strains.

The newly-formed skin has no indentations, or lozenge-shaped marks, on it, like the old, nor has it the living principle so strong. The new cutis is at first very vascular, but afterwards becomes less so, the vessels perhaps being obliterated, or converted into absorbents, and so becoming white.

Cuticle.—That formed on the new cutis is at first horny, but afterwards shining. It is sooner restored than the cutis, and is formed at once from every part of the cutis.

Rete Mucosum.—This is much longer in forming than the cuticle, and sometimes is never recovered, as we see in wounds, blisters, &c., in blacks, their skin in that part remaining white for ever.

EFFECTS ON THE CONSTITUTION.—I have divided diseases into local and constitutional; and when on local, I observed that they, and especially inflammation, had secondary or sympathetic affections, which were immediate or remote. The immediate were considered when on inflammation, namely, the sympathetic fever. The remote are now to be treated of.

One would suppose that the suppurative would only so far affect the constitution as by the preceding inflammation which produces it; but the contrary is sometimes the case, and the suppurative will produce worse symptoms than the inflammation itself. The condition which the constitution takes on after suppuration is sometimes productive of those diseases termed nervous, as locked-jaw, hysteria, spasm on the muscles of respiration, restlessness, debility, &c., all of which seem to arise from the suppurative action, and are not salutary effects, but harass the constitution and even produce death. The locked-jaw I shall defer for the present, and consider hectic or sympathetic fever.

Hectic fever is a remote constitutional sympathetic affection, and appears to have a very different origin from the other remote sympathizing effects, though in general the consequence of a local disease. It is the constitution affected by a local disease, or irritation, which it is conscious it cannot cure; for while the inflam-

mation lasts, which is only preparatory to an immediate effect of most injuries, in those parts at least which can most affect the constitution and call up her powers, there can be no hectic.

It takes its rise from a variety of causes, which I shall divide into two: 1st, From an affection of vital parts; 2d, From an affection of parts not vital. The only differences between these is in the time of the hectic's coming on, and its rapidity and violence when it does come on. In vital parts, hectic will be produced by many complaints which will not produce it in other parts, as scirrhus of the stomach or mesenteric glands, also diseases of the lungs or liver. These also produce other symptoms, according to the nature of the part injured and of the injury; as coughs, when in the lungs; sickness and vomitings, when in the stomach; dropsies and jaundice, when in the liver.

When the hectic arises from disease in a part not vital, it is generally in parts where such a quantity of mischief can take place as to make the constitution sensible of it, as the large joints. In small joints, although the same local effect takes place as in large ones, yet the constitution is not made sensible of it, so that we find scrofulous joints of the toes, &c., not affecting the constitution with hectic, and the ankle, elbow, and shoulder are much longer in affecting the constitution than the knee or hip.

Although hectic commonly arises from some incurable local disease of a vital part, or of a common part of some magnitude, yet it may be an original disease of the constitution; the constitution may fall into the same action without any local disease whatever.

Hectic may be said to be a slow mode of dissolution; the general symptoms are those of a low or slow fever, attended with weakness; but more the action of weakness than real weakness, for on the removal of the part causing the hectic there is immediately the action of strength produced. The particular symptoms are: debility; small, quick, sharp pulse; the blood forsakes the skin; there is loss of appetite; often vomiting; wasting; tendency to sweating, especially when in bed; constitutional purging; urine clear at one time, and at another depositing a branny brick-dust sediment; dissolution. This disease has been supposed to arise from absorption of pus; but I have long thought that the blame has been improperly laid to the absorption of pus, and the following facts will make this evident. First, hectic takes place where there is disease, and no suppuration in vital parts; also in many inflammations before actual suppuration has taken place, as in many of the large joints, called white swellings, while the same kind and quantity of inflammation and suppuration in any of the fleshy parts, and especially such of them as are near the source of the circulation, have in general no such effect. Therefore in such cases it is only an effect on the constitution, produced by a local complaint having a particular property.

I have said that with all diseases of vital parts the constitution

sympathizes more readily than with many other parts; and also all diseases of vital parts are more difficult of cure than those not vital; as also diseases of bones, ligaments, tendons, affect the constitution more readily than of muscles, skin, cellular membrane, &c.; and we find these general principles hold good in universal remote sympathy with local disease of those parts and structures.

When a disease is in the vital parts, and is such as does not kill from the first constitutional effects, then the constitution becomes teased with the complaint, which is destroying the necessary actions of health which are vital. In diseased joints there is not a proper power, or rather, perhaps, disposition to produce salutary inflammation and suppuration for their recovery; therefore the constitution is irritated with an incurable disease.

If absorption of pus always produced such symptoms, I do not see how any patient who has a large sore could escape this disease, because we have as yet no reason to suppose that any one sore has more power of absorption than another. If in those cases where there is hectic the absorption of pus is really greater than when the habit is healthy, it would be difficult to determine whether the increase of absorption is a cause or effect. If it is a cause, it must arise from a particular disposition of the sore to absorb more at one time than at another, even while in a healthy state. What reason we have to suppose that a sore in a healthy constitution has power to absorb more at one time than at another, I do not see. If this increase of absorption does not depend on the nature of the sore, it must take its rise from the constitution; if so, there is a peculiarity of the constitution; therefore the whole of the symptoms cannot arise from the absorption of pus, and the cause must be a peculiar constitution and absorption combined.

If the absorption of matter produced such violent effects as are ascribed, which are never of the inflammatory kind, but of the hectic, why does not venereal matter produce the same effects? We often know that absorption is going on by buboes taking place, yet no symptoms appear until the matter appears to produce its specific effects, and these symptoms are not very similar to those called hectic, though from reasoning we should expect that venereal matter would act with more violence than common matter from a healthy sore.

Again, as matter is often formed on the inside of veins in inflammation of those cavities, and this matter enters directly into the circulation, why have we not the hectic symptoms in these cases? We have the inflammatory, and sometimes death. We also find the matter of large abscesses which have been produced without visible inflammation, such as many of the scrofulous kind, wholly absorbed, and that in a very short time, yet no bad symptoms follow.

From all these facts and reasonings we may conclude that the absorption of pus from a sore cannot be the cause of so much mischief as has been generally supposed. If it was owing to matter in

the system, I do not see how the symptoms could ever stop until suppuration ceased; yet we often do find that they get well before suppuration ceases, even when no medicine was given; and in the case of inflammation of the veins, there is reason to believe that after all the bad symptoms are gone suppuration is still going on, so that though matter is still passing into the constitution from the vein, hectic is not produced, which it must be if it was caused by matter getting into the circulation.

But I much doubt the fact of absorption going on more in one sore than another. In large abscesses hectic seldom comes on till they are opened, though they have been forming matter for months. In such cases the disposition often comes on soon after opening the abscess: in others very late; but till the stimulus for restoring the parts is given no such effect can take place. If the parts were disposed to heal, no such hectic disposition would come on. In diseased joints also, if the parts are capable of taking on salutary inflammation we shall have only the first sympathetic inflammatory fever; but as they seldom do this, the constitution is teased by the complaint not taking on immediate and salutary steps towards a cure. Hectic, therefore, would appear in some measure to depend on the parts being stimulated to produce an effect beyond their powers, and this stimulus is sooner or later in taking place.

Treatment of Hectic.—We have as yet, I am afraid, no cure for this. I believe the cure consists in the removal of the cause, viz.: the local disease. Strengtheners and antiseptics are recommended. Strengtheners are proposed on account of the debility, which has evidently taken place; and antiseptics, from the idea of absorbed pus giving the blood a tendency to putrefaction. To prevent both these effects taking place the same medicines are recommended, namely, bark and wine. Bark will in most cases only assist in supporting the constitution; I should suppose it could not cure the constitution of the disease; however it may render it less susceptible of it. When hectic comes on from some specific disease, as from venereal irritation, the bark will enable it to support it better than it otherwise would have done. Wine, I am afraid, rather does harm, as it increases the action of the machine without giving strength, a thing to be carefully avoided. However, I have not yet made up my mind about wine.

When hectic arises from the disease of such a part as the system can bear the loss of, the part should be removed. On removing the cause (as by amputation of an extremity,) the pulse, from being very quick, returns to its usual state; I have likewise known the patient sleep the first night without an opiate, after having had little or no sleep for a week before, and the sweats called colliquative have been stopped; and I have known purging immediately to stop. Perhaps the pain and newly excited action of the constitution may assist in the abatement of the symptoms.

Of Dissolution.—To the hectic I have joined another disease,

arising from suppuration, which I have called dissolution, because few recover from it.

It may arise in long-continued suppurations, which may not be incurable in themselves, and in this it differs from hectic. Dissolution seems more the effect of the past than of the present, which is the reverse of hectic. We never find this take place in consequence of small wounds, or such as affect the constitution but little, but rather after bad compound fractures, amputations, &c. It appears more in hospitals than in private practice; more in large towns than in the country. In cases of compound fractures and amputations, we find the constitution often capable of going through the inflammatory sympathetic fever, producing suppuration and granulation, and continuing this for some time, yet sinking under them at last, and often without any apparent cause, the effect taking place more readily if the patient was in full health before the operation, than if he had been for some time accustomed to hectic symptoms.

The first symptoms are generally those of the stomach, shivering; vomiting immediately follows, if it does not accompany it; a small quick pulse; perhaps bleeding from the whole surface of the sore: often mortification and speedy dissolution. Here is a very fatal disease taking place in some almost immediately, and when everything appears to be within the powers of the animal. It therefore cannot immediately arise from the sore itself: yet the sore certainly assists, because we never see the disease take place where the sore is healed.

The removal of the local disease will not prove effectual for the cure of this as it does that of hectic, nor do I find anything that has any effect.

CHAPTER XV.

PRACTICAL ILLUSTRATIONS OF THE PRECEDING SUBJECTS.

Union of a broken tendon;—rupture of the tendo-Achillis;—principles of treatment;—impossibility of causing voluntary contraction of the muscle;—management of the injury;—pain and inflammation trifling;—length of cure.—Empyema;—varieties of contained fluid;—symptoms differing;—ultimate effects of contained fluid the same;—to be distinguished from disease of the heart.—Symptoms of the disease peculiar;—general;—sympathetic.—Operation.—After-treatment.—Pericarditis.—Adhesion;—suppuration fatal.—Emphysema from fractured rib;—operation to be avoided.—Peritonitis;—symptoms;—rapid progress;—true and erysipelatous.—Puerperal, not from inflammation of the uterus;—causes;—arising after tapping.—Hernia.—Cæsarian section.—Opening cavities of joints.—Ganglions.—Inflammations of the eye.—Phlebitis following venesection;—causes;—extension;—frequency in the horse.—Arteritis.

Union of a broken Tendon.—The treatment of a broken tendon is very similar to the treatment of a fractured patella, because

their uses, and in some degree their situations, namely, the giving way of an intermediate substance between the power (that is the muscles,) and the resistance. All come under one general principle of cure, though the mode of treatment is somewhat different.

These intermediate parts are principally tendons, probably some ligaments, and bones. The fracture of a tendon is probably always produced by the power being in action, and the resistance counter-acting at the same time and with great velocity. We might suppose that every tendon in the body would be liable to such accident, but I believe there is only one that stands any chance of such effect by the natural exertions of the body; this is the tendo-Achillis.* There is also, probably, but one bone in the human body which can be broken in the same way, that is the patella; though there may be instances of processes of bone being turn off near their insertion, which would be somewhat similar.

The tendo-Achillis seems liable to be broken by the natural actions of the body, from having at the same time to sustain the action of the power and of the resistance also. When it has only the action of the muscles to contend with, there is no danger of its rupture, because the tendon is capable of supporting a much stronger power than that of the muscles. Though the tendon is continually in this state, yet there is little danger, because when the action is voluntary all the actions tend to support one another; but in a careless unguarded action the motion is more violent and quick, and the part less prepared against it. I believe fracture of this tendon often happens when a person is fatigued and off his guard, as after dancing, &c., and after the muscles have acted spontaneously, as in the cramp; at least it happened to me after dancing, and after a violent fit of the cramp. The general principle of cure in parts displaced is the replacing them in their natural situations, which is the whole cure in some, as dislocations, and the first step to be taken in every case where the continuity of parts is broken.

When the tendon is broken it is seldom attended with pain in the parts. It commonly gives a pain, which instantly seizes the calf of the leg. The noise or snap which it produces gives no idea of the mischief done; but being at the same time attended with pain in the calf of the leg, and the patient not being able to walk as usual, he conceives that some one has struck him with a hard body on the calf, and if he is so situated as not to have been liable to a blow, he becomes puzzled to conceive what can have happened. We generally find that the muscle is thrown into a state of cramp when the tendon gives way, losing the power of relaxation by the will, or of itself. As a surgeon is seldom present when such an accident hap-

* [This is a mistake: the tendons of the patella, triceps extensor cubiti, and quadriceps extensor cruris are sometimes ruptured from a sudden and abrupt exertion of these muscles. An example of the latter kind is at this moment in one of the wards of St. George's Hospital. I may also mention that fractures of the collar-bone, from muscular exertion, are not very uncommon.]

pens, it is often allowed to remain some time in that state; but the pain often leads to the right mode of cure, the patient squeezing the muscle down with his hands, which a surgeon should do if at hand. The broken ends will always at first be some distance from each other, because they are pulled apart by opposite forces.

The parts should be allowed to remain nearly in their natural position; no inconvenience will attend a small separation of the broken ends of the tendon, namely, half an inch or so; whereas considerable disadvantage would arise if we were to push the two broken ends together by throwing back the heel (which has been the general practice). The only circumstance that would seem to forbid such practice, namely, letting the broken tendons remain without a bandage, is, that the muscle will lose half an inch of its power of contraction, which the motion of the ankle may or may not lose; but though this may be lost at first, we know muscles will acquire it again afterwards, and therefore no attention need be paid to this objection. The advantage of not throwing the heel up, and of allowing the tendon to heal nearly in its natural position is, that the patient may be enabled to walk from the very beginning of the cure, a very desirable circumstance.

However, it is not necessary to adhere rigidly to either of these modes of treatment, but to adopt a medium between the two, which will be best. The heel may, therefore, be a little raised during the time of walking only, by raising the heel of the shoe. A roller should be passed several times round the calf of the leg, and kept constantly applied, as we cannot guard against the involuntary actions of the muscles; and at night we may apply an apparatus consisting of a leathern slipper or sock, with a strap from the heel to be fixed to a belt, in order to steady the muscles.

When the tendo-Achillis is broken, there is but very little inflammation attendant; but some general fulness comes on about the small of the leg and ankle, the skin looks dark from the effusion of blood, and the parts have a firm feel, from coagulable lymph being thrown out. This firmness of the cellular membrane increases near to the fracture laterally, and this assists in keeping the tendon in its place. The inflammation hardly requires any particular treatment when the foot is in a proper position.

As I would not restrain the patient from walking almost from the very beginning, (the inflammation may prevent it for the first day or two,) it is necessary to give him some directions how he is to manage the muscles under the cure, as walking cannot be performed in the usual way. I have recommended to keep the position of the foot nearly at a right angle with the leg, as in standing, but not quite so, the heel being a little raised, by some pieces of leather put into the shoe, which may be removed one by one. When he walks he must turn his toes out, and carry the inside of his foot forwards, without attempting to bend the joint of the knee; indeed, the latter precaution is unnecessary, for this motion is only necessary when the heel can be raised from the ground, which he cannot do. This foot will

be for some time the leading foot in walking, for it will be an easy motion to set it forwards before the other, especially if the heel is not much raised; but it will be impossible to set the other foot forwards and leave this behind. The patient will be hardly able to mend his pace for two months, except it be by getting familiar with his present mode of walking. The ankle and foot will swell occasionally, especially in the evening; and this may continue more or less after the tendon is united, but is of no importance. Three or four weeks after the accident he may remove the roller from the calf of the leg, and about the same time leave off the slipper at night. We cannot say when he may use the muscle of this tendon: that will depend on the fitness of the tendon to be used, which can only be known by the power the patient has of putting it to use. About two months after the accident we find him gradually bringing his toes more and more forwards, until he at last walks as usual.*

It is impossible for a patient with a fracture of the tendo-Achillis to act with the gastrocnemius and soleus muscles, if he were to try to do so. When the Duke of Queensberry broke his tendo-Achillis he was immediately aware of what had happened, and pointed out to me the broken ends. He readily submitted to my reasoning: walked about his room as well as he could, and found it impracticable to contract the gastrocnemius muscle. Some surgeons thought the tendon could not be broken, because he was walking about his room; but in such a case the patient has no more power to contract his gastrocnemius and soleus muscles than to jump over St. Paul's.

Of simple Fractures.—A fracture is the solution of continuity of a bone, whereby more or less of a cavity or space is allowed between the broken parts. It often, if not always, happens that the surrounding soft parts are also torn by the broken ends of the bone. On the surface of this broken or torn part are the mouths of many ruptured vessels, which immediately fill the cavity with blood. This is the first stage of the bond of union. This blood, having the living principle in it, unites with the torn surfaces, in the same manner as in ingrafting the living parts of animals. An inflammation generally comes on, similar to that which produces adhesions where there is no ruptured vessel, which is of service in this case for the better union of surrounding parts, where extravasated blood cannot enter, by which means the callus becomes larger than it would otherwise be. Vessels are either continued from the old parts into this extravasated blood, or it forms new

* [The period of perfect recovery is generally protracted several months before the ultimate organization of the uniting medium is effected, in consequence of the low powers of vitality which tendinous parts possess. Simple incised wounds of tendons, as in amputation, are observed to heal without difficulty; but the union of ruptured tendons is a much slower process, depending upon the slow reproductive powers of these parts. At first the union is by cellular membrane, which gradually becomes harder and tougher: very often it becomes osseous, as in Mr. Hunter's own case; but very frequently it remains a fibro-cartilaginous knot, which never assumes the tendinous character.]

vessels in its own substance; this substance then goes through the regular stages of ossification, becoming first cartilaginous and then bony. Thus new parts are formed and old ones united without the occurrence of any considerable inflammation, and all owing to this circumstance of the extravasated blood being preserved, and allowed to retain its living powers. All the surgeon has to do in such cases is to put the parts as much into their natural situation as possible, and to keep them there by art in the easiest way to the patient that he can. The same idea and the same practice is extended to all unions by the first intention.

The position of the patients themselves, when the fracture is in the lower extremities, (abstracted from the nature of the fracture itself,) has been of late a consideration. It has been a question whether they should lie on their backs or on their sides. I am inclined to prefer the back; for, from the experience of one patient, who had the same thigh-bone broken twice, lying on the back was the easiest, though it was the last, method of lying; and I conceive that it is a position that can be borne longer than that on the side.

The pain arising from fracture is but little, only from the bones either tearing or wounding the soft parts. The inflammation is of course but little, if the parts have not been violently torn.

Of Compound Fractures.—If the violence of the fracture has continued the laceration through the skin, so as to have allowed part of the blood to escape, and to have exposed the remainder sufficiently long to allow it to lose its living principle, so as to become an extraneous body, unfit for the purposes of union, then the suppurative inflammation must take place, and granulations finish the union which the blood was incapable of doing. In this case the granulations become the origin and seat of formation of the callus, and go through the regular changes until they become ossified, as was the case with extravasated blood in simple fracture. In these cases considerable fever and inflammation, proportioned to the local injury, come on.

There are two cases which partake of the nature both of simple and compound fracture. The first is, where the injury was a simple fracture at first but afterwards becomes a compound, which I shall call the simple compound fracture; the other is when the fracture is a compound one at first, but the external wound so small, and the soft parts having sustained so little injury, as to require very little different treatment from what happens in the simple fracture; and this kind I call a compound simple fracture.

Of the Simple Compound Fracture.—This is owing, in some cases, to some part of the extravasated blood losing its living principle, and then acting as an extraneous body; in others it is owing to the sharp end of the bone pressing against the inside of the skin and causing it to ulcerate. In these cases we see inflammation come on, at first, as in simple fracture, with that mildness which generally attends such cases; but some days after a stimulus is given by the broken pieces of bone, or by the blood which has lost its living

principle, or from the parts being beyond the power of union by the first intention, and the suppurative inflammation comes on.

The cases which I have seen of this kind have been much less dangerous than fractures that were compound from the first. The only reason I can assign for this is, that the whole of the blood produced from the lacerated parts does not lose the living principle, so that a considerable portion becomes so much a part of the living solids during the first few days as to be able to keep its ground, only a portion of it acting to produce the suppurative inflammation, which is therefore less.

The treatment of the simple compound fracture is very simple: the limb may be bound up in general as in a simple fracture, with splints and a roller, only leaving a free space for the change of dressing and to keep the parts clean.

Of the Compound Simple Fracture.—The effect of this is similar to the foregoing, though the cause is different. There are cases of compound fracture where the wound in the skin is but very little at first. If the broken ends of the bone have not done much mischief to the soft parts, and only made a small wound in the skin, they may be treated as simple fractures, which gives us an opportunity of retaining the uniting matter. By immediately closing up the wound with a bit of sticking-plaster, or a little lint soaked in the blood and allowed to dry on it, the greater portion of the wounded parts and broken ends of the bone will unite by the first intention, and only those parts of the solids which are exposed will suppurate. This small suppuration will oblige the surgeon to leave the wound in the skin free from bandage, in order to be enabled to look at it occasionally; though, from some accounts, it might seem that even this was not necessary. This mode of treating it as a simple fracture obliges it to heal as such. This practice has been followed even when the laceration in the skin was considerable; but I have not seen a sufficient number of cases to say how far it may be extended.

Inflammation, Suppuration, and Ulceration of circumscribed Cavities.—All circumscribed cavities, as the pleura, peritoneum, &c., admit of the three inflammations. They may be formed into true and distinct abscesses by adhesions inclosing the matter, as in common abscess. If the inflammation does not stop at the adhesive, then suppuration follows, and ulceration also becomes necessary for the exit of the matter, which is an extraneous substance. A material circumstance happens in the inflammation of cavities containing vital parts, which is, that very little sympathy exists between the surrounding part and the parts contained, whence the inflammation of the one is not always continued to the other; thus, inflammation of the peritoneal coat of the abdomen and of the intestine may exist without inflammation of the inner coat of the intestine. But this does not hold good universally, for inflammation of the tunica vaginalis spreads through the whole body of the testis.

Inflammation of the Pleura.—This membrane is more subject to

inflammation than any other investing membrane. Probably this does not arise from any difference of structure, but from its situation, by which it is exposed to the operation of cold air, and from its contact with the lungs. Perhaps there is hardly one in fifty who at the age of fifty, is without adhesion of the lungs to the pleura. We often find the lungs adhering to the whole surface of the pleura lining the thorax, and it does not seem necessary that inflammation should take place on both surfaces to produce adhesion. Abscesses may be formed here, either having the matter inclosed in a particular bag or diffused through the whole side, forming one large abscess; hence true and false empyema.

Empyema.—The cavity of the chest is subject to the two diseases of other circumscribed cavities, dropsy, and inflammation and suppuration, or empyema. These two kinds of disease will have some of their symptoms very different, though the symptoms arising from the ultimate effect, namely, the collection of fluid in the chest, will be nearly the same in both. But as this cavity has connexions with parts whose symptoms when diseased will be very different from those of this cavity simply, and as those parts will sympathize with the diseases of this cavity, we shall find that a complication of symptoms will often take place which may mislead the judgment so much as to make us suspect that the sympathizer is the seat of the disease.

This sympathizer is the heart; and as a disease of this part has produced symptoms which have been lately called *angina pectoris*, we find that it requires particular attention to be paid to the specific symptoms of empyema, to separate them from those of the heart.

The general cavity of the chest is divided into two distinct cavities: therefore whatever disease affects one simply, cannot affect the other by its having affected this.

Water may collect in the cavity of the chest almost at once, without giving much previous notice. It may be the consequence of various causes, as cold, fever, &c. The symptoms arising from the presence of a fluid are either peculiar, common, or sympathetic, which last may or may not occur.

The first true specific or peculiar symptom arising from an extraneous fluid, in some considerable quantity, in the cavity of the chest, is difficulty of breathing, which is always an attendant, and is distinguished from difficulty of breathing from other causes by this, that the patient is always able to breathe much better in certain positions. This position will vary according to circumstances: if water is only on one side, the person can lie on that side, and on that side only; if on both sides, he can lie on his back, not horizontally, but with the chest raised as much as possible. He feels the fluctuation of the fluid within the chest whenever he moves, especially when he raises himself up. I have heard patients often say that they could hear the fluid move. The fluid is felt pressing like a weight on the diaphragm. An anasaruous habit often takes

place, and sometimes ascites. These two last symptoms would seem to arise from a universal irritable debility.

The second, or common symptoms with other diseases, of those parts are difficulty of breathing, and of expanding the chest; great lowness and oppression; a feeling of suffocation or of dissolution.

The third, or sympathetic, symptoms are often great irregularity of the pulse, palpitations, flutterings.

When the symptoms are known to arise from the presence of a fluid in the chest, it should in general be let out by an operation called *paracentesis thoracis*, which is only making an opening into the thorax and allowing the fluid to flow out. The wound should be made to unite by the first intention. The fluid to be evacuated may be of various kinds: as blood from a ruptured vessel, or wound made with a ball or cutting instrument; or extravasated serum, as in *hydrops pectoris*; or pus, the consequence of inflammation.

Whatever the fluid is which is to be discharged, I have always found suppuration take place in all the operations I have seen performed; for when the discharge was nothing at first but serum, (as water in ascites), yet afterwards it gradually changed into pus. This arose simply from keeping the external wound open. I am inclined to think that nothing could have saved these patients but resolution of the inflammation, and the parts falling back into their natural disposition. This, as I have mentioned, sometimes takes place in common abscesses, especially those of a scrofulous kind, and in the present cases it might the more readily take place, as there is here no change of structure or granulation of the whole surface of the pleura or lungs. However, wounds have been made into the cavity of the thorax, suppuration has taken place, and yet the patient has got well; but how this has been brought about I cannot tell.* General Murray, to whom I have often expressed a wish to peep into his chest, has been twice wounded in this way. I tried the experiment by shooting a dog; but both Nature and the dog cheated me, for I intended to keep open the wound until the whole surface of the pleura had taken on suppuration, when I meant to let Nature have her way and cure the dog as she pleased, and then I intended to kill the dog and see what she had done. But the dog would always lie on the wounded side; and when, after death, I examined it, I found the lungs had adhered to the wound and prevented the inflammation spreading over the surface of the lungs. The wound, after the evacuation, therefore, should be united as quickly as possible, to prevent the whole pleura from sup-

* [There cannot be any doubt that the cure is effected in these cases by the obliteration of the cavity of the pleura, partly by coagulable lymph which is effused at the same time with the serum or pus, and partly by granulation; the cavity of the pleura being precisely under the same conditions as a common abscess, and healing by the same methods. In these cases the patient seldom regains the power of complete expansion of that side of the chest, which always remains in a more or less contracted and flattened state.]

purating, which would destroy the patient in nineteen cases out of twenty.

Inflammation of the Pericardium.—The cavity of the pericardium is not so apt to produce universal adhesions as that of many other cavities.* When it goes no further than adhesion the patient lives, although this produces many disagreeable symptoms, as palpitation of the heart, irregularity of the pulse, great oppression and faintings, which in general produce a bad state of health, a great debility, and symptoms which have gone by the name of *angina pectoris*. If the inflammation approaches to suppuration, it will certainly kill.

Emphysema.—It will not be improper here to say something of the treatment of patients affected with emphysema arising from a wound in the lungs by a fractured rib, for if any surgical operation is necessary, great caution is required not to make the wound communicate immediately with the cavity of the thorax, in order to avoid the mischief above described.

If the lungs are wounded by a fractured rib, we know that the pleura must be wounded, and that there must be a communication between the cells of the lungs and the cavity of the thorax. There is also a communication between this cavity and the common cellular membrane of the body by the wound in the pleura. The air escapes from the lungs into the cavity of the thorax, and in the act of respiration is squeezed into the cellular membrane of the body. The internal wound does not inflame so quickly as the external, because the internal depends on extravasated blood for the renewal or adhesion of parts; and the wound of the lungs, from its being in contact with the air, may be considered as an external wound, while that of the pleura is an internal one; the former will therefore probably heal sooner than the latter, whereby the air will be confined in the cavity.

The operation for the relief of this disease is making a perforation into the cavity for the relief of this disease, which operation should be religiously avoided, because it will produce the suppurative inflammation all over the internal cavities, and most probably make the wound in the lungs ulcerate. If an external opening is necessary, it should be made at some distance from the fractured rib, and never on the rib itself. If this is not attended to, it will make what was at first a simple a compound fracture, which probably would produce the same effect as an incision at once into the cavity of the thorax; or if it did not produce this evil, would produce adhesive inflammation quickly about the fractured rib,

* [This may be accounted for by the unintermitting action of the heart, which must present the most unfavourable conditions imaginable for the organization of the lymph. The opposing surfaces of the pleura or peritoneum may be preserved by the patient in the most perfect state of apposition during the progress of inflammation, by breathing only by the chest or diaphragm, according as the case may be. But the heart has only one mode of action, which must continually tend to disturb the process of union, just in the same manner that the continually recurrent action of the sphincter ani prevents the cure of fistulæ in that situation.]

which would prevent any future escape of air from the pleura, which should be allowed; and for the same reason the patient should not have a roller bandage put on, as this would cause an impediment to the respiration by the other lung, and, by preventing the escape of the air, cause the whole contents of the thorax to be pressed to the other side.

Peritoneal Inflammation.—This inflammation is attended with great pain, not of the colicky kind, but a violent soreness or tenderness on external pressure. The fever or sympathy of the constitution, arises much higher than if it arose from the inflammation of a common part, and runs through all its stages much sooner than another part. When the immediate cause of these constitutional symptoms is not known, and the effects are violent, it has been called a fever, and the chief attention has been directed to checking this fever; but the symptoms are merely the consequence of the inflammation in a part by which the constitution is easily affected; so that if it were possible to restore the healing disposition to the cavity of the abdomen, the other symptoms would vanish and health be restored. A diarrhœa sometimes comes on, but at other times there is costiveness, both of which I am inclined to think may be considered as sympathetic affections.

It is perhaps almost impossible at first to say what the inflammation is, whether the true inflammation or the erysipelatous, because we are only guided by the constitutional symptoms, not by the appearances. A person in seemingly tolerable health attacked at once with so violent a local disease will be at first roused, which will make it appear a truly inflammatory complaint; but if it is erysipelatous he soon sinks. Still at first the apparent indication would be bleeding, and that largely; but if it is of the erysipelatous kind we may be led by those symptoms beyond the quantity suitable to the constitution. Yet I do not know what we can do better; I should be inclined to reduce the patient to the lowest pitch rather than allow suppuration to take place, for that would certainly kill. In whatever light we consider an inflammation of the peritoneum that is capable of producing suppuration, it is one of the most dangerous diseases we can meet with. How far in such cases it might appear desirable to make an opening into the abdomen, and throw in warm water repeatedly to wash away the matter, I will not undertake at present to determine.

Peritoneal Inflammation after lying-in.—Inflammation often attacks some part or the whole of the peritoneum in women some days after childbirth, and hence has been called puerperal fever, from supposing it to be a fever peculiar to that state, and the inflammation of the peritoneum a consequence of this fever, whereas the fever is only a sympathetic symptom of the inflammation; but as this inflammation is connected with vital parts, the sympathetic fever is so much the more violent and dangerous. I believe I am the first who formed this idea of this disease.

Why such a disease should occur after so natural an operation

is not easily explained. It does not arise from an inflammation of the substance of the uterus first taking place, as we might at first naturally expect; for if the uterus did inflame in consequence of delivery, there would be no more necessity for the peritoneum of that viscus to inflame than for the peritoneum of an intestine to inflame when the intestine is itself inflamed, which it seldom does; and if the peritoneum of the uterus inflamed in consequence of inflammation of the uterus, that is not a necessary cause why the whole peritoneum should inflame, excepting the inflammation was carried so far as to produce suppuration on that part of the peritoneum. But the substance of the uterus generally appears as sound as in those who have no such disease; however, although the uterus is to appearance sound, yet it may be in such a state as to give the same stimulus of imperfection as if it were entirely removed or not existing. To illustrate this we may bring forward the circumstance of two cocks' combs that were frozen and thrown off as dead sloughs, for I suppose from analogy that the frozen parts were still alive, and if so we may see that a living part may be so circumstanced as to give the stimulus of death to the parts with which it is connected. That the inflammation of the peritoneum arises from the stimulus of imperfection is also evident, because if a man is wounded in the belly with a sword which has also wounded one of the intestines, if the wound in the abdomen is closed, and unites by the first intention, the wound in the intestine will unite with some part with which it comes in contact, either by extravasated blood or the adhesive inflammation, and no further trouble will ensue, because the stimulus of imperfection has not been given. But if a man is wounded in the belly, and there is no wound of the viscera, yet if the wound is kept from healing by the first intention, the whole peritoneum becomes inflamed immediately, not from the spreading of inflammation by the continuity of surface, but the consciousness of imperfection in the membrane itself, by which the whole is brought into the same action. It is probable that the uterus suddenly contracting, the neighbouring parts, becoming sensible, as it were, of the loss of a part they have been accustomed to, inflame. Sometimes adhesion will take place, and a circumscribed abscess will be formed in the lateral and lower part of the belly, and probably the inflammation was chiefly in the round or broad ligament; first there is hardness and pain, then prominence and fluctuation, when it may be safely opened.*

* [Mr. Hunter has fallen into two errors on this subject: first, in ascribing puerperal peritonitis to an ideal cause; and secondly, in supposing that the constitutional fever invariably arises from inflammation of the peritoneum. There cannot, I should think, be the least hesitation in ascribing the inflammation of the peritoneum which ensues on child-birth to the irritation which the uterus has suffered during that process, for the inflammation is not only sometimes confined to that part of the membrane which covers the uterus, and always is most violent there, but it invariably commences from that point. The fact, however, of the same cause giving rise to inflammation of the adjacent organs is completely subversive of the imaginary cause assigned by Mr. Hunter, arising from the

Inflammation of Peritoneum after tapping.—A man whom I tapped at the hospital died the third day. I said he died of the puerperal fever. This was smiled at in the hospital, and some were pleasant in remarking on the curiosity of a man being delivered; but a few months afterwards another having the same fate, I convinced them, by dissection, that he had died of suppuration of the peritoneum, which we must admit to happen in puerperal fever. Frequently the inflammation does not go so far as to produce suppuration, and then the patient commonly recovers; but it often runs the whole course and produces death. It seldom attacks those parts of the peritoneum that are pretty sound, or where the disease is not of long standing; but where the disease has arisen from a bad constitution or diseased viscera, it seldom fails of attacking them, especially in the second or third tapping.

Hernia.—The consideration of inflammation of internal cavities leads me to make a few remarks on hernia. We might suspect that the operation for hernia would often be the cause of universal inflammation of the peritoneum, but I believe in bubonocoele and femoral hernia it is generally prevented by the sides of the skin of the abdomen being pressed together after the operation. This inflammation is met with after the operation for umbilical hernia, because the edges of the wound cannot be brought together.

In this case we should contrive that a portion of the epiploon shall remain at the bottom of the wound, and if it is not protruded I think it would be the best way to find it if possible; in this way, by adhesion taking place round the opening, the general cavity would be excluded.

Cæsarian Operation.—In this operation, and in every other instance where the lips of the wound do not come well together, assistance should be had from art to unite them as closely as possible. If it should be found necessary to use sutures, care should be taken that they do not pass through into the cavity of the abdomen, as by this they would produce effects exactly contrary to what was

“consciousness of imperfection.” No such imperfection can be supposed to be felt by the veins, the absorbents, or the ovaries, and yet these parts are frequently inflamed, independently of the peritoneum. Of forty-five fatal cases of puerperal fever which were examined by Dr. Lee at the British Lying-in Hospital, (in all of which was found some morbid change, the effect of inflammation,) the peritoneum and uterine appendages were found inflamed in thirty-two; in twenty-four there was uterine phlebitis; in ten there was inflammation and softening of the muscular tissue of the uterus; and in four the absorbents were filled with pus. In short, the irritation of parturition may extend to any or all the circumjacent parts within the sphere of its influence, and give rise to puerperal fever by exciting local inflammation. Local inflammation probably *always* exists, but the peritoneum is not *always* that part which the inflammation attacks.

The morbid appearances presented on dissection are extremely various, and closely resemble those which arise from inflammation of the peritoneum following the great operations of surgery, as lithotomy, hernia, &c., viz., large effusions of lymph, turbid serum, or pus separately or blended together in different proportions. Pus is not an invariable product of this inflammation, as might be inferred from the text.]

wished,—that of rendering the cavity perfect; for as these continue, suppuration of the wounds made by them will come on, they acting as a seton, by which the exposure of the cavity will be greater, though perhaps, from the irritation they would occasion, adhesions would be formed at the bottom of the wound before they suppurated, which might prevent the admission of air.

In a woman in whom I performed this operation, and who died, I found, thirty-six hours after death, that the intestines had adhered to the inner edge of the wound of the belly for the breadth of an inch: the uterus was entirely within the pelvis; but the edges of the wound in the uterus had not closed at all, and a good deal of coagulated blood was found in it. I should therefore in future wait until the bleeding had nearly stopped from the uterus before I closed the external wound.

Bladder.—It may be said that the bladder being so seldom inflamed after the operation for stone, is an objection to my supposition that an opening into any circumscribed cavity, by the exposure and consciousness of imperfection induced in that cavity, is almost necessarily productive of inflammation of that cavity; but here it must be observed that the internal surface of the bladder partakes more of the nature of an outlet than of a circumscribed cavity, admitting therefore less of the adhesive inflammation, and that it is more accustomed to and less affected by the action of extraneous matter, which must render it less susceptible of inflammation from exposure.

Cavities of Joints.—It is from the disposition that the cavities of joints have to fall into the suppurative inflammation when an opening is made into them that union by the first intention does not take place. The greatest care should be taken to put this in their power if possible, for as they do not readily run through the regular stages of inflammation, they give rise to the more violent symptoms. When they suppurate it is very tedious, and then the parts are apt to die and slough, which makes these accidents of such dangerous consequence. In cases of wounds I should think a simple bandage would be best. We should avoid making stitches, because they tend to produce inflammation, as was explained under wounds of the abdomen.*

Sacculi mucosi.—There are other cavities, besides those of the joints, which are liable to inflammation from irritation; these are the sacculi mucosi, which are in fact joints formed between tendons and tendons, tendons and bones, bones and skin. They are subject to disease, causing an increased quantity of fluid in them, not from inflammation, but from slight irritation. They are seldom attacked

* [The lighter and cooler the dressings in this sort of accidents the better. Perfect repose of the organ, an easy position, cold lotions, and a little lint dipped in blood over the wound, is probably the best, as it is also the simplest mode of treatment. If symptoms of inflammation arise, they should be combated at once by a copious venesection, which should be repeated, if necessary, until the inflammation is subdued.]

with suppurative inflammation; nor does the absorption of the fluid which they contain readily take place. Ganglions have been sometimes dispersed by soap plasters, and sometimes, although rarely, by electricity. A gentleman was cured of a ganglion on the wrist, which had returned after being dispersed by a blow, by the *Balsamum Canadense*, applied thick and bound on tightly. I would advise a blow to rupture the sac; but the fluid is soon reaccumulated. For a radical cure, an opening should be made, and this prevented from healing by the first intention, that it may suppurate and heal by granulations. As these are connected with joints, weakness and stiffness may be produced for a time; but this is overcome by motion.

Inflammation of the Eye.—I shall consider the eye now as a cavity. Inflammation of the eye often takes place after extraction of the crystalline lens. The lips of the cornea not adhering by the first intention, suppuration ensues, which is followed by a shrinking of the globe. The same effects are sometimes produced when an opening is made to discharge the accumulated aqueous humour, as also when the globe has been suffered to burst spontaneously. This has sometimes happened from accident, the opening into the anterior chamber not closing; but probably these effects only take place where either the crystalline lens or the vitreous humour have been disturbed or lost in part, but more particularly the latter, as the adherence of the crystalline to the processus ciliares would prevent the inflammation extending; but when separated, the posterior part of the eye becomes conscious of this, and suppuration follows. The pus may be seen through the cornea, but no fluctuation can be felt. It is necessary to distinguish between simple opacity of the cornea and the accumulation of pus in the anterior chamber; they may appear similar, and both may be present at one time; the first may be of long standing, the last must be recent: an inflammation must have very recently preceded the accumulation of pus. If the progress of the opacity can be observed,—but it cannot always, especially in children,—we may distinguish them: if in the cornea, a dimness may be seen to begin over the whole, and get white by degrees, or it may remain in a point, and remain there only; if pus, it will begin at the bottom of the cornea, and its shape will be semilunar, the straight line being uppermost, and as it advances the line will rise till it comes to the top, and if first seen in this state it is with difficulty distinguished.

If the disease is an opacity of the cornea, reabsorption is the only cure, and no operation is to be performed; in the other case, the removal of the pus is the cure. There appear to be two natural modes of cure; one the absorption of the pus into the constitution, which I have often seen take place; the other is ulceration of the cornea, as in other abscesses, and discharge of the pus. The latter is the worst mode of cure, for the pus, by its pressure on the crystalline lens, may disease it, and an irritation will be kept up by the

distention, which should be avoided, as the consequence will be the obliteration of the cavity of the eye, as in any other abscess.

This, then, leads to an artificial cure, which is by removing the pus at an early period, when we see it will not be absorbed, by an incision like that for removing the lens, by which we avoid the second or natural cure; but it is not always perfect, as we cannot heal the wound by the first intention.*

Of the Brain.—I have not seen a sufficient number of cases to determine how far inflammation attacks the pia mater when it is exposed in trepanning, but from the protrusion of brain in such cases inflammation may be inferred, as I have mentioned already. I never saw a case recover where the dura mater had been punctured,† which I attribute to inflammation of the pia mater extending to the brain below.

Inflammation of Veins.—The cavities of veins are subject to inflammation, either in consequence of inflammation of surrounding parts, or from themselves taking on the inflammatory disposition and involving the surrounding parts.

This inflammation of veins happens sometimes after bleeding, and has been attributed to a pricked tendon or nerve by some, and by others to a bad constitution; but if we consider this consequence arising from bleeding more accurately we shall find that it happens after bleeding in veins where no tendon could be wounded, and when no nerve is in the way, as often as in the others, and frequently in constitutions where there is no apparent want of health, and also where the wound, on bleeding from another part in the same person, probably with a view to cure the former, has healed readily.

The manner in which these inflammations come on shows very plainly that they arise from the wound made by the lancet not healing by the first intention, and in different arms we have also the different degrees of extension of the inflammation. In some, suppuration has only spread superficially, the veins and parts below having united, and the inflammation only seated between the vein and the skin, and then it is of little consequence; in other cases the skin shall appear united, but not close to the vein, so that a small abscess shall

* [Hypopium, or the accumulation of pus in the anterior chamber of the eye, is very often the result of inflammation of the whole internal part of the globe, which rarely admits of a cure. When it proceeds from an ulcer situated on the internal part of the cornea, a cure may be expected, particularly if mercury is employed, which causes the effused pus to be absorbed. Neither of these circumstances, however, can justify the surgeon in making an opening into the cornea, unless there is at the same time an excessive accumulation of purulent fluid, giving rise to great pain and tension of the globe. In which cases relief may be afforded by letting out the pus, although little hope of saving the sight can be entertained from the operation.]

† [Wounds of the dura mater undoubtedly very much aggravate the ultimate danger arising from other accidents, but are not in themselves universally fatal. On the contrary, numerous cases are recorded of extensive penetrating wounds of the brain which have recovered without a single untoward symptom.]

form between the skin and the vein. But when this imperfect union of wounded parts is carried on to the cavity of the vein, then more mischief ensues; the external wound in most cases festers or inflames, then suppurates and ulcerates; then the vein inflames from being an imperfect cavity, the inflammation extending both towards the heart and from it; and also, for a considerable way, the surrounding parts join in the inflammation. We find in these cases all the different degrees of inflammation in different cases; sometimes it goes no further than the adhesive inflammation, and suppuration is prevented by adhesion being allowed to take place in this part. The veins in such cases are ever after obliterated, and may be felt, after the surrounding inflammation has subsided, like hard cords. But these slighter effects are not always all, and suppuration will unfortunately too often take place.

The suppuration has all the degrees of violence and extension. It is often so confined as only to form a small abscess near the orifice; this arises from adhesions having taken place in the vein a little above and below the orifice. In many cases the inflammation and suppuration extend further, adhesions not having taken place; sometimes a very long abscess is formed, and often there is a series of abscesses, following one another in the direction of the vein, between the orifice and the heart; but not always in this course, for we find them sometimes between the wound and the extreme parts. I have seen from a wound in the foot the saphena inflame all up the leg and thigh, nearly to the groin, and have been obliged to open a string of abscesses almost through the whole course.

I have almost always found that inflammation has taken place in the larger veins which pass through a part that has been violently inflamed. This disease often happens in horses after bleeding, for the operators do not take proper care to close the orifice in these animals. This has sometimes proved fatal; but whether from the inflammation extending to the heart, or from the matter that is secreted in the veins passing in considerable quantity into the circulation, I cannot say.

The method of preventing these ill effects is to bring the edges of the wound carefully together, when the bleeding is finished, that they may unite by the first intention. I would recommend a compress of linen in preference to plaster; for I imagine that the blood itself being applied over the orifice is a kind of bond of union which is more natural than any other application. I have seen more sore arms after bleeding where a plaster has been applied than in any other cases. I have also seen it several times where the orifice has opened a second time and bled again, and has not been properly closed.

Treatment.—If inflammation has just come on and not arrived to suppuration, a compress should be applied to produce adhesion of the sides of the vein, whereby the inflammation may be prevented from reaching the suppurative stage. If the suppuration is come

on, let pressure be applied immediately above, to prevent the matter from passing to the heart, by producing adhesion there.

Inflammation of Arteries.—Arteries unite by adhesion when their sides are compressed. This we find after the division of the larger arteries after amputation. I never have seen arteries suppurate, and do not know whether they ever do suppurate, nor what would be the consequence. Perhaps it would produce mortification; but I am about to determine this by experiment.

CHAPTER XVI.

OF HYDROCELE.

Theory of the cure simple, but in practice the operation often fails.—Description of the disease;—distinguished from others.—Encysted hydrocele;—its nature;—common to all ages and constitutions;—disappears spontaneously in children;—rarely in adults;—symptoms;—state of the testicle to be ascertained;—hydatid;—scirrhus;—false membrane covering testes;—adhesion of testis to cicatrix after puncture;—former cicatrix to be avoided.—Palliative treatment;—hæmatocele; diffusion of blood into the cellular tissue;—suppuration following simple puncture.—Radical cure;—various methods recommended;—object of all;—adhesive inflammation occasionally occurs;—obstacles to its taking place.—Erroneous notions of the mode of cure.—Injection;—tent;—seton;—caustic;—laying open sac;—violence of the latter method;—all severe.—Practice of removing testicle when enlarged;—doubtful if always required.—Causes of failure of all the above operations,—of each in particular.—Mode of operating recommended;—after-treatment, and consequent symptoms.—On the actions of medicines.—On diseased dispositions and actions.—Of the difference of different parts to heal.—Of one disease curing another.

THE disease called hydrocele is a very common one; it consists of an undue secretion of the fluid which moistens the tunica vaginalis testis, and admits of a cure according to the laws of inflammation, suppuration, and granulation, which is the process of a common abscess. Although the theory of the cure of a hydrocele is very simple, yet no disease affecting the human body, and requiring an operation for its cure, has called forth the opinions and pens of surgeons so much as this disease.* The reason of this is easily accounted for; for they have gone so far as to find that every mode

* [This was no doubt the reason which led Mr. Hunter to enter so fully into the consideration of the subject. "At the time," Sir Astley Cooper remarks, "I was attending Mr. Hunter's lectures, the town was divided in opinion as to the best mode of performing the operation for hydrocele; and so great was the difference of opinion among the students of the different hospitals, that it was quite ridiculous to observe their warmth on this subject. The operation, by injection, as recommended by Sir James Earle, was not introduced until a few years afterwards, but has since been universally acquiesced in as one of the most simple as well as most effectual remedies of surgery.]

of operating but their own has failed, but have not noticed the cause of failure. It was enough for them that they could condemn. They rested contented with having recommended a method which was to them infallible; nor did the condemnation of this favourite method of theirs by others rouse them into an inquiry as to the cause of its failure.

The scrotum in man has two circumscribed serous cavities in it, which may become the reservoirs of any part of the blood that may be extravasated, but which are generally in these cases distended with water, forming an aqueous cyst. Besides this, there are other extravasations of water into the scrotum, but they are common to every part of the body as well as it.

Each of these cavities is called *tunica vaginalis testis*, and when either of them is filled with fluid it is called a hydrocele.

There are other cavities formed in these parts from disease, like those formed from similar diseases in other parts, and which may be called hydatids. I believe they are more common in these parts and in the ovaria in women than in most other parts, probably from their being glands of a peculiar kind.

But every distention of the scrotum with water is called a hydrocele: even water collected in the cellular membrane of the scrotum in anasaruous habits, where it has only soaked through from the parts above, or arises from irritation: this kind might be called diffused hydrocele. This collection in the cellular membrane is often so great as to be diffused into the cellular membrane of the penis, which always produces phymosis, with twisting of the skin of the body of the penis, from the frenum not being so extensible as the common skin. This often proves very troublesome, by confining the urine. The radical cure of this kind of hydrocele will be the cure of the disposition, which is commonly more constitutional than local. But this cannot always be done; and we may then give a temporary relief to the parts where the scrotum is become considerably enlarged, with much phymosis. It then becomes necessary to procure an evacuation of the water, which can easily be done by making small punctures with a lancet or needle in the most depending part of the scrotum, and also, if necessary, at the end of the prepuce. However, some attention must be paid to the state of the patient; for, if very weak and debilitated, mortification may take place at these orifices; therefore the smaller and fewer the punctures the better.

Another watery swelling, similar to the above, is described, namely, an anasaruous state of the spermatic cord. This disease I never saw.*

* [Pott and Searpa have both described this disease, which they represent as consisting of an enlargement of the cells of the spermatic cord, which in process of time, particularly towards the bottom of the tumour, merge in one general cavity, divided by a number of septa more or less perfect. Essentially, therefore, it does not differ from encysted hydrocele of the cord, except in the mode of its commencement.]

The encysted hydrocele is a collection of water in some cyst situated in these parts. This species of hydrocele has been divided into three kinds, according to the situation of the water: first, when it takes place in the tunica vaginalis testis; secondly, when it occurs in the body of the testicle: thirdly, when in the spermatic cord; and, indeed, by the same mode of multiplying species, I could from my own knowledge, make a fourth and fifth, namely, hydatids at the back of the testicle, where the vessels enter, and hydatids on the body of the testicle,* within the tunica vaginalis testis; which last may be complicated with hydrocele of the tunica vaginalis, as I have seen. These two last, as also hydrocele of the cord, are only hydatids in those parts. The hydrocele in the body of the testis must also be classed with hydatids: but this I have never seen. Of those on the outside of the testis I have seen several cases. All these tumours, however, are properly only divisible into two kinds; hydrocele of the tunica vaginalis, and hydatids; for it does not alter the disease whether the hydatids be in the spermatic cord, cellular membrane, scrotum, or body of the penis; it is still hydatid, wherever placed.

As the symptoms arising from the testicle being in a state of irritation are different from those of irritation in other parts, so we shall find that the symptoms arising from, and the cure of, these encysted hydroceles will be different from those arising from hydatids in the body of the testicle; whereas these will be similar to those of the tunica vaginalis testis because in both they have connexion with the testicle. But the symptoms arising from the cure of hydatids not connected with the body of the testicle will be similar to common inflammation in all cases of the disease.

The cause of the anasarcaous hydrocele is very evident: it arises from a universal disposition to throw out serum: and, from the situation of the part, it becomes a universal detainer of the water as it is descending from the upper parts.

In the encysted hydrocele the cause is generally not known, especially of the hydatid kind. However, the hydrocele of the tunica vaginalis often arises from a disease of the testicle; for I have observed that many who are operated on for the radical cure show

* [According to Sir Benjamin Brodie, these swellings commence between the tunica vaginalis and tunica albuginea of the testicle, and not in the proper structure of the testicle as has generally been supposed; they do not therefore essentially differ from encysted hydrocele of the epididymis, except in being more strictly bound down by the tunica vaginalis which will necessarily tend to limit their growth, and on this account to obviate the necessity of surgical interference.

Simple hydatiform cysts in the body of the testicle are referred to by Dr. Hodgkin. See *Med.-Chir. Trans.*, vol. xv. p. 289.

It will scarcely be necessary to remind the reader that the term hydatid is employed by Mr. Hunter in the old acceptation. The true hydatid has no connexion with the surrounding textures, and is probably a parasitical animal, endowed with independent vitality and a peculiar mode of propagation. These do sometimes occur in the gland of the testicle in association with malignant disease; but never, I believe, as an original and independent affection.]

a disease in the testicle ; also I have seen several hydroceles that at first were hardly anything but true hydrocele, the testicle hardly appearing diseased, yet in time (viz., a year or two) the testicle has increased gradually, and the water has been diminished so much, that hardly anything was left but a large diseased testicle, and all this time giving little or no pain.

Hydrocele of the tunica vaginalis is common to all ages ; it is met with in children, in middle-aged and old men. In children they arise sometimes before communication between the tunica vaginalis and abdomen is completely cut off, so that any fluid from the abdomen can pass down and distend the bag. In appearance this somewhat resembles a rupture ; for when the water is pressed upwards, it makes a swelling close up to the ring, but by squeezing, it can be made to pass up into the belly. In these cases a slight bandage or truss should be worn for some years.

Hydroceles are common to every kind of constitution ; not more common to the dropsical and anasarous person than to the healthy, which is not the case with ascites or hydroys pectoris ; therefore it is probable they arise from a disease in the part, or are what may be called truly local. They are common in all countries ; but they would appear to be most common in warm climates.

In general we find them go away of themselves ; in young lads, therefore, in such cases, I never recommend any mode of treatment. In grown people they seldom or never go away ;* I have known only two or three cases in which they have disappeared without the obliteration of the sac. I have tried several stimulants, as mercurials diluted, turpentine, &c., by way of application, but they had not the desired effect. However, I once thought the latter, namely, turpentine, checked the progress of a hydrocele. Even letting out the water simply does not prevent the accumulation again taking place, whence the term *palliative cure*.

Diagnosis.—The encysted hydrocele consists of a bag filled with water placed in the scrotum, sometimes a little higher on the spermatic cord. The principal points to be known or discovered are, whether, when a tumour appears in this part, it contains water ; and, if possible, the true situation of that water as respects the testicle : for there is another disease that will imitate this so as to be with great difficulty distinguished from it, which is a diseased testicle simply.

Some ruptures put on an appearance somewhat similar to hydrocele, and when the gut contains a fluid, it often gives an obscure

* [Many examples are on record in which old hydroceles have disappeared spontaneously ; an event which is most likely to happen, according to Sir Astley Cooper, when the disease has originated in inflammation ; or, according to Sir Benjamin Brodie, about once in twenty cases. However, there is no rule on this subject. As ruptures of the tunica vaginalis from external injury are not followed by a permanent cure, we have no right to suppose that slighter degrees of external violence will have this effect ; although something of this kind has frequently been supposed, when spontaneous cures have taken place.]

fluctuation; so that hydrocele is but too often confounded with rupture.

Fluids contained in a circumscribed bag are commonly easily made to pass from one side of the bag to another, unless the bag is extremely full and thick in its coats, and then there will be only a gentle receding of the fluid from the side pressed on. This is made plain to the senses by applying our hands or fingers to two different parts of the bag, and pressing those two parts alternately; this is called fluctuation. But solid bodies also, of a loose texture, inclosed in a bag, can be made to recede from pressure, and give nearly, if not wholly in many cases, the sensation of a complete undulation; a feeling which the testicle sometimes takes on in one of its diseases. Therefore, as this body sometimes conveys the feeling of fluctuation of a hydrocele, and as the latter often acquires a hardness like that of the testicle, the difference we might expect to find between the feel of water and of the testicle is in some cases wholly lost.

I think that in general a distinction is to be made in the shape; for I observe that in general when the testicle swells, it flattens on each side, having an edge forwards and backwards, and is not, like hydrocele, of a pyramidal figure, with the apex upwards, passing into the cord towards the ring of the abdominal muscles, and even in some cases passing a little way into the ring, with (in many cases) a slight contraction at the part where it does pass into the cord. But this cannot be set down as an invariable rule, for the testicle will vary in shape according to the disease and other circumstances; and hydrocele will also vary in shape according to circumstances, and if it be an hydatid, and not within the tunica vaginalis, it will have less of the pyramidal form, though even then it often retains or acquires that shape; but if flat, it may be suspected to be the testicle. It has been recommended that we should put a light on the opposite side, and see if the tumour has a degree of transparency; but this can only take place where it must be evident from other symptoms, where, namely, the skin is not thickened, and the fluctuation is therefore perfect.*

* [There is only one disease of these parts which there is much danger of being mistaken for hydrocele, and that is the medullary disease of the testicle, which it is often very difficult to distinguish from hydrocele. Besides the points of difference which have been noticed in the text, I may observe that *the oval shape* of the testicle in fungus hæmatodes is generally marked with some degree of bulging, which destroys the perfect ovality of the swelling; that *the cord* may be felt perfectly distinct for a greater extent of its course than in hydroceles of equal size; that *the feel*, although generally pulpy and elastic, is not uniformly so, but softer in some parts than it is in others; that *the weight* of the tumour is greater than that of hydrocele, and the *superficial veins* more swollen; and, finally, that the swelling commences uniformly in every part, unlike that of hydrocele, which begins at the lower part of the scrotum and gradually ascends. The test by the lighted candle ought not to be despised, especially as it conveys useful information as to the real situation of the testis, and very often gives immediate knowledge of the disease, when, from the tension of the swelling, it is scarcely

But supposing the disease to be well ascertained to be water, we are not in all cases properly prepared for an operation until its situation with respect to the testicle is exactly ascertained, for the situation of the testicle with respect to the general tumour will vary according as the water is situated. When the water is in the tunica vaginalis, as is most common, or in an hydatid in that bag, the testicle will mostly, if not always be placed at the posterior part of the tumour, and there is consequently but little danger of doing mischief to the testicle by any of the operations, unless adhesions between the tunica vaginalis and testicle have previously taken place, and then the testicle will be confined to the side on which the adhesions are, as well as to the posterior part. If water is contained in an exterior hydatid, then it is not at all certain in what part of the general tumour the testicle may be. Perhaps it is often not possible in such cases to distinguish the situation even by the sensations of the patient, and therefore we must always be on our guard when the situation is not ascertained. If the testicle is found on any side of the scrotum except the posterior, it is more than probable that the water is not within the tunica vaginalis, but in some cyst or hydatid placed contiguous to the testicle, or that some adhesions have taken place between the tunica vaginalis and testicle, cases of which I have seen. If an hydatid is within the tunica vaginalis, and fills up the whole tunic, it will in general be similar to the case of water within the bag itself; but it admits of a variety of complications, which may lead the surgeon into error even in the time of the operation, a case of which I think I have seen. The complication appeared to be the following: water both in the hydatid and tunica vaginalis, which led the surgeon to remove the whole as a scirrhus testicle; for on opening the tumour and letting out the water, he found another tumour within this, which he naturally took to be the testicle itself, and which of course led to the extirpation of it. On examining the parts after removal, it was found to be simply another cyst of water, with the testicle sound within it, or rather behind it.*

There is another mode of complication which the above case gave me an idea of, and which I do conceive I once met with in a patient of my own, namely, that inflammation had taken place over the whole sac, so as for the sac to have become lined with coagulable lymph, similar to what I have seen in other cavities; that this lining at last became part of the sac; but that a part of this lining had separated from it, and the space between the two had become filled with water, as also the general cavity, so that they formed a sort

possible to discern fluctuation. In doubtful cases, it is always expedient to insert a lancet or explorative needle into the tumour previously to the operation of castration.]

* [There is reason to believe that this mistake has frequently occurred. The danger, however, of confounding hæmatocele with disease of the testicle is still greater, although the history of the case, and the suddenness with which hæmatocele commences, will never fail to point out the difference to the intelligent surgeon.]

of double hydrocele. This case and the anterior hydatid would, I presume, assume the same appearance.

We should naturally suppose, when the situation of the testicle is not immediately known, and where the temporary cure has been performed with success, that there could be but little doubt of the testicle being at some other part of the tumour than the part where the wound was first made; but this is not always to be trusted to, for the operation of the temporary cure often becomes the cause of adhesions of this part of the sac to the body of the testicle. This very case occurred to me when about to perform the radical cure, for after having made the first incision on the cicatrix, and cutting through the tunica vaginalis as I thought, I was cutting on the body of the testicle. In performing this part of the operation I suspected all was not right, but did not in the least expect to find the testicle, and therefore cut carefully on till I came to the tubular substance of the testicle. I of course desisted, and performed the operation in another part, at no great distance from the first, as the testicle is not a large body, and I did not require to make a second incision in the skin. There did not appear to be any additional symptoms in this case, in consequence of the wound in the testicle, which seemed to heal as readily as a wound elsewhere would do. When the testicle is in the fore part of the tumour, either from the water not being in the tunica vaginalis, or from previous adhesions there, and its situation is not known or attended to, and the operator makes an incision on the fore part where the testicle is, like that in the above-mentioned case, and he finds he is cutting on the testicle, and determines to shift his ground, I would advise him either to go lower, or to ward one side with his future incision; but at all events not to go above the testicle, to get into the sac, for there he will most probably find the spermatic cord passing along the fore part; and by cutting through it he may cut the spermatic artery and castrate the patient, or cut the vas deferens, which will in all probability render the sore fistulous. A case of this kind I once saw, where the spermatic artery being cut, the blood escaped into the cellular membrane of the scrotum. This circumstance of the cellular membrane of the scrotum being sometimes filled with blood in consequence of an operation, may at first mislead the surgeon to suppose it is mortification, if he is not acquainted with the cause.*

* [Every species of hydrocele, as Mr. Hunter has remarked, is reducible to two forms, that of hydrocele of the tunica vaginalis, and encysted hydrocele of the cord. The first, or common form of hydrocele, is a true dropsy of the tunica vaginalis, and arises from the same causes which produce dropsies in other situations. The encysted hydrocele of the cord is an adventitious production, which has no existence in the primary structure of the parts, and ought to be classed with serous cysts occurring in other parts of the body.

The varieties of common hydrocele depend on the form or structure of the sac, or the nature of its contents. The ordinary situation of the testicle in hydrocele is two-thirds of the way down the tumour at the posterior part; but, as Mr. Hunter has remarked, the tunica vaginalis is liable to every possible form of adhesion, which will necessarily occasion great differences in the position of the

Of the temporary Cure.—I shall not say much with regard to the palliative or rather temporary cure of hydrocele, as it consists only of the evacuation of the water in the easiest and shortest way, without doing anything to prevent a recurrence of the disease, and is hardly so nice an operation as bleeding. The same care is

testicle and its vessels, as well as of the external configuration of the hydrocele. When the testicle has united to the anterior part of the tunica vaginalis, at the lower part, the vessels of the cord are generally spread out over the anterior surface of the tumour, and become liable to be injured by the trocar. Sometimes the tunica vaginalis presents a honeycombed appearance on its internal surface; occasionally it is much thickened, especially in those who have resided in hot climates; or converted into cartilage, in which more or less extensive depositions of bone have taken place; at other times it is presented under the form of an hour-glass contraction, which may be either partial or complete, or may, after being partial at first, become complete afterwards. When there are no adhesions, and no thickening of the sac, the hydrocele may attain a very considerable magnitude. I have known several cases in which the apex of the tumour has advanced considerably beyond the external abdominal ring, so that no part of the spermatic cord could be distinctly identified, and the quantity of fluid exceeded from three to four pints; but a case is mentioned by Sir Benjamin Brodie which increased till it hung down to the patient's knees. The fluid of this form of hydrocele resembles that of ascites, that is, it is of a deep yellow colour, and is readily coagulated by heat. It loses its transparency, however, and becomes whitish when inflammation has been present, or becomes of a chocolate hue of various shades when from any cause the smaller vessels of the sac have been ruptured, so as to cause an effusion of blood into the cavity of the cyst: sometimes it contains a number of micaceous particles, consisting of adipocire; at other times a number of small bodies, looking like melon-seeds; and occasionally one or more loose cartilages, which exactly resemble those which are contained in the joints.

The serous cysts which are developed in the spermatic cord and epididymis, or between the membranes of the testicle, are wholly different from the common hydrocele of the tunica vaginalis, and resemble those which are not unfrequently met with beneath the common integuments of the body, on the surface of the liver and kidneys, in the breast, the ovary, and in other situations. It is possible that they may be produced by the distention of one or more of the cells of the cellular membrane, which a partial inflammation or some other cause may have shut off from their communication with the adjoining cells; but this has not been ascertained. The secreting cyst is extremely thin and loosely attached; and the fluid, instead of being like that of hydrocele of the tunica vaginalis, is remarkably transparent and watery, and does not coagulate by heat. The occurrence of these cysts on the body of the testicle, or epididymis, will necessarily give a lobulated and very irregular appearance to this organ, and expose it to be mistaken for malignant disease, although this mistake may easily be avoided in general, by a careful examination of the part with the fingers, or by a lighted candle. When they occur high up, they are liable to be confounded with hernia, especially as from their loose connexion with the neighbouring parts, and consequent great mobility, they may easily be pushed up towards the abdominal ring, or even through it, and in that case be protruded again whenever the patient coughs. In such cases, however, there is always a visible bulging above the situation of the ring, which cannot be entirely dispersed; besides, hydrocele in this situation may always be distinguished by pushing the tumour downwards, and then feeling for the spermatic cord above the tumour; under such circumstances, no impulse will be communicated to the finger when the patient coughs.

Hydrocele of the tunica vaginalis may coexist with encysted hydrocele of the spermatic cord, hernia, varicocele, diseases of the testicle, and hæmatocele. These complications may generally be distinguished without much difficulty, provided all the circumstances of the case are duly considered.]

necessary as above described to ascertain the situation of the testicle, lest the operator should puncture the body of the testicle, and wounding it, will certainly fail in his intentions with regard to the evacuation of the water, and may be led by his failure to mistake the disease, and suppose it of more consequence than it really is; not to mention the injury which might be supposed to arise from injuring so sensible a part, though I believe this last circumstance is not of so much consequence as might be imagined, for I know a case where the water was placed in a distinct bag on the posterior part of the testicle, so that this body could not be distinguished from the general tumour by the surgeon, who therefore supposed it to be a hydrocele of the tunica vaginalis, with the testicle in its proper place; and that he might avoid wounding the testicle, he pushed his lancet into the fore and lower part, but no water came. This he repeated four times, nearly in the same place, with the same effect; and on a further knowledge of the disease it was found that all those four wounds were in the testicle; yet no bad consequence followed, nor did the patient suffer more pain than afterwards, when the lancet went into the cavity of the bag where there was only water.

In such cases the best guides are the feelings of the patient, and not that of the surgeon,—a circumstance to which too little attention has been paid, for a great many diseases may be distinguished by the sensation of the part when in pain. It is well known that the pain felt on squeezing the testicle is very different from that arising from other parts; therefore if it is this organ that is swelled, the sensation arising from squeezing the tumour will be the same in every part, and will be that sensation which is peculiar to the testis; but if it is a hydrocele, or any adventitious swelling, the sensation will be different in different places, that is, when the part pressed is the testicle, the pain will be such as is usually felt on squeezing the testicle; and when the watery part of the tumour is pressed, the sensation of common pain only will be felt. From attending to this circumstance only, I have been able to distinguish a hydrocele from a pulpy testicle, when the disease was supposed by other surgeons to be the latter. However, there are cases in which I have still had my doubts about the situation, from the impossibility of pressing on it with sufficient firmness to give the true sensation when the coats are much thickened.

The operation for the temporary cure requires an incision not bigger than that made in bleeding; or it may be done with a small trocar. When the water is let out in this way, it sometimes happens that a vessel is wounded either in the skin, cellular membrane, or sac, which bleeds pretty considerably, and the blood is either diffused into the cellular membrane of the scrotum, giving the appearance of mortification, or extravasated into the sac, and fills it up probably as large as ever. Both these effects from tapping I have seen, but never saw any bad consequences arise from them, the blood being always absorbed. I could even conceive a good consequence to arise from the last, as it might be the means of

forming a bond of union between the sac and the testicle by the first intention, which I have seen take place partially. This is one of the diseases called hæmatocele, described by authors; they have also described others of a different kind, but taking place from the same accident; and also some cases of hæmatocele of the spermatic cord, which I have not seen.

A blow has been known sometimes to burst the bag, by which means the water has been diffused into the cellular membrane of the scrotum, and a temporary cure has been produced in this way. The patient, and also the surgeon, have been alarmed sometimes with this case; for blood has been diffused with water into the cellular membrane, which has given the idea of mortification having taken place.

I would advise that the operation for the palliative cure should not be performed but at a time when the patient can lie by, as inflammation may come on and produce the radical cure where only the temporary was intended. A gentleman who was usually tapped every six months begged I would do it for him before he went to Paris. I objected, telling him my reasons. He was pleased with them, and postponed the operation until his return, and fortunately for himself, for it actually happened that inflammation succeeded the tapping, which proved the radical cure.

In cases where such an occurrence takes place, the wound made by the lancet or trocar has generally healed up in some measure; but inflammation has taken place in the whole sac, and suppuration has come on, and ulceration has led the matter to and through the skin. As the orifice has in many cases healed up, the cause of this inflammation is not so evident as it would be had the sac remained exposed, and the inflammation is therefore not so quick in its termination, and in many cases seems to be stationary, as if suspended between resolution and suppuration. In other cases resolution will take place when the inflammation has been very violent, and when we have been every day in expectation that suppuration would ensue. In this case I would advise you to open the sac, and complete the operation by suppuration.*

Of the radical Cure.—As various methods have been practised and recommended to effect a radical cure, it naturally leads me to make some observations on those methods, for they cannot be all equally proper in all cases; however, I mean not to be very particular in my criticisms on those different methods that have been proposed, only so far as to point out different cases where they may be attended with inconvenience, arising from particular circumstances in them; nor shall I mention these different methods further

* [Besides the suppuration of the sac which occasionally follows the palliative operation, particularly in West Indian patients, the sac sometimes mortifies in old people. Sir Astley Cooper has mentioned two cases of this kind, which were followed by death, from which he has judiciously enforced the propriety of keeping *old* persons to their beds whenever this apparently simple operation is performed.]

than will illustrate my own opinion. I do not even mean at present to recommend one method in preference to another, but only to show the advantages that each has, although they all proceed on the same principle, leaving to the surgeon, and in some measure to the patient, to choose for himself after he has thoroughly considered all the different circumstances of the case; while at the same time I mean to show that more depends on the mode of treatment after the operation has been performed than on the mode of operating.

The radical cure depends on the obliteration of the cavity which contains the water. There are but two natural methods in which obliteration of the sac can probably take place, namely, by our two inflammations, adhesive and suppurative; for union by the first intention can hardly take place, though I can conceive it possible in some cases where the operation for the temporary cure has been performed.

I have observed that this is a disease which never arises from the constitution, and seldom or never affects it; nor are the parts themselves much affected by the consequence of the disease, namely, the accumulation of water, especially if it is occasionally let out. It is necessary, therefore, that we should be very particular in our method of cure, for whatever danger arises rests in the mode of cure alone. We should always make a material distinction between an operation which is to cure a person of a disease which will probably kill of itself without an operation, and an operation which is performed to cure an inconvenience only, and where the danger is not in the disease but in the method of cure.*

The method of cure by adhesive inflammation is union of every part of the cavity with itself; and as the testicle makes part of the cavity, the tunica vaginalis must also unite with it. However, this method is one which I need hardly take notice of, as it is one which very rarely occurs in these cases, and as yet we have no certain method of procuring it without running a risk of the suppurative following it. It is much to be wished that such a method of cure could be put in practice with certainty and success. That it is possible for such a method to take place I know from experience, and also from the dissection of dead bodies, for we very often find the cavity of the tunica vaginalis entirely obliterated, and fixed to the tunica albuginea; but it is more than probable that in such cases there never had been water in the cavity, and therefore adhesions the more readily took place, these adhesions being a very common

* [M. Dupuytren, in his *Leçon Orales*, used to remark that operations of convenience much more frequently prove fatal than others, such, for instance, as amputation of the thigh for old ankylosis of the knee, the removal or discharge of large bursæ, &c.; so much so that he was accustomed to decline operating in such cases. Surgeons occasionally allow themselves to be persuaded, by the importunities of a patient, to undertake operations against which their own judgments loudly declare: surely such conduct ought to be reprobated, as proceeding either from culpable weakness or some motive still more reprehensible.]

consequence of swelled testicle from gonorrhœa. Perhaps letting out the water, and only keeping the wound open a short time, might just procure the adhesive state, and by allowing it to heal up before the suppurative took place the latter might be prevented; however, I believe the knowledge of this critical time, if there be such, is beyond the power of human sagacity; therefore I believe it would not answer in most cases. Indeed I have seen suppuration follow simple tapping; and admitting we were masters of the degree of inflammation, yet many arguments might be brought against the probability of its success, for we might suppose it not possible for the adhesive to produce its effects universally: first, because it is next to an impossibility to evacuate the whole of the water, and that remaining would be sure to keep some parts separate; secondly, as the tunica vaginalis is much enlarged in such cases, the collapsing of the skin might prevent adhesion taking place at all; thirdly, the contact could not be so uniform as to bring all parts into apposition. I know but of two cases where this method occurred successfully.

Observations on the different methods of radical cure.—I believe I am the first who have taught that the radical cure is performed by inflammation, suppuration, and granulation; it was the general opinion, and I was always taught, that it was by adhesion; but if union took place by adhesion, without granulation, then we should not have had suppuration.

The most simple mode recommended for obliterating this cavity consists of making a small opening into the sac, and introducing an extraneous body to prevent union by the first intention in the wound, by which means universal inflammation should take place over the whole surface of the sac. This probably was not thought sufficient to raise an inflammation, therefore it was recommended to throw into the cavity by this orifice stimulating liquors, so as to increase the inflammation; they had not an idea of an imperfect cavity producing inflammation of itself. In very old cases, where suppuration is but slow in its progress, this mode may be of considerable service.

Another method was by seton, which was no more than a double tent, or two wounds instead of one.

The ideas annexed to these modes of practice were, that they produced adhesions of the sides of the sac to each other, and also to the testicle, by the first method of union. Great pains have been taken in a treatise published by Mr. Douglas to show the impossibility of the sac collapsing so readily as to unite in every part of its extent. But this is neither the effect one might naturally expect to ensue from the methods put in practice, nor what really takes place in the very cases where they were tried, as is easily known from the symptoms described by the operators themselves, which were plainly those of the suppurative inflammation, though they did not see it in that light.

So far was this disease treated to procure adhesions of the tunica

vaginalis to obliterate the sac, and perhaps it was on the same principle that a small caustic was at first applied, and which has been used with success; but in a late publication (Else's) it is recommended on principles very different from the foregoing, for it is there supposed that the whole tunica vaginalis sloughs off and passes out through the opening. But that the whole tunica vaginalis should slough away by this treatment more than when the whole cavity is laid open, is not to be conceived. It is, however, a well-known fact that the tunica vaginalis often throws off partial sloughs, and in some very old cases may slough wholly away; but it is not to be expected as a general effect. When it does slough, this is owing entirely to the diseased state in which the sac is at the time, and not to any particular virtue in the method of cure. I suspect that after caustic, more than after other methods of cure, there is an appearance very much like sloughing, so much so as very readily to deceive; this appearance is the coagulable lymph thrown into the cavity among the water from the internal surface of the sac in the time of the adhesive inflammation.

From the ignorance of the true principles of cure, and the uncertainty of success from the former methods, practitioners were led naturally into the method of opening the whole sac or bag; but most probably they were led to this practice by imitating what may be called the natural cure, in cases where the sac had burst, and a radical cure ensued. It is most likely that the bursting of the sac never happened from mere distention, but from preceding inflammation and suppuration, which might arise from the distention, and in that light is only to be considered as an abscess. And here it will be proper for me to observe, that such a case might lead a surgeon to form an erroneous idea of it; for if he had not been consulted from the beginning of the disease, namely, when in the state of hydrocele, and also had not made himself master of what the disease now is, he might readily suspect it to be a diseased testicle, and might be confirmed in the opinion by the inflammation and suppuration, unless the appearance of these should cause him to suspect it not to be cancerous; but if it does not, he will be most likely led to the extirpation of the whole mass, unless by first laying open the abscess freely he should gain a knowledge of what the disease is. Even then, however, he might continue to be deceived, for the inflammation having attacked the body of the testicle, he will find it very much swelled, and to appearance diseased, especially if the abscess should not have been thoroughly opened. A case of this kind I once saw, and also the mistake above-mentioned: the abscess was opened, and the testis exposed and condemned; when I saw the abscess and the testicle at the bottom, I suspected what the case was; the testicle was not removed, and the patient got rid of his hydrocele.

It is possible that a case of this kind might happen where the disease would not show itself so manifestly; for if the water had been contained in a hydatid, the testicle would not be exposed by

opening the abscess, and the whole tumour might appear to be the body of the testicle. In a case of this kind the sick heavy pain and the pain of the back which attend diseased testicle would not be present, nor the pain in the small of the back; so that if these symptoms were attended to, there might still be a means of saving the testicle.

Although this natural cure might have shown the possibility of a cure being effected by inflammation and suppuration over the whole sac, and that very probably no more was necessary to produce it than making an opening into the sac, and not allowing it to heal by the first intention, yet it was certainly not understood, for it was thought necessary by some to open the whole sac, and indeed to make it still more secure by cutting off a part of the sac, or even the whole, which indeed was all that they could, unless they had dissected off the tunica albuginea from the testicle. As this method of operating is much more violent than the others, of course its consequences are more violent; it is, therefore, evidently not to be put in practice to its full extent, if a less violent and as sure a one can be devised. However, do not suppose that I mean to prefer a patient's ease during an operation to his cure.

In every one of the operations for the radical cure of hydrocele, the suppurative inflammation is an effect which is pretty violent, and therefore in many cases of thickened sac it produces an inflammation which is absolutely sufficient to kill some parts which are not able to support the actions of life, and which are thrown off in the form of sloughs.

Incision, it has been said, is to be preferred, because it gives the operator an opportunity of seeing the state of the testicle, which has been found very much diseased in such cases, so that the operator has thought himself obliged to have recourse to extirpation of it. This is a case which sometimes happens; but I suspect that, if the symptoms were particularly attended to, we might inform ourselves exactly of it before the operation was performed.

Perhaps in most cases it would be right to perform the temporary cure first, which would show the state of the testicle at the time; and as the sac generally fills again pretty fast, there could be no danger of the testicle becoming diseased during the time of refilling: for in most cases where the testicle is diseased there is an obscurity in the feel; it will give the feel of water in some positions, and in others of more of a solid substance. However, in any of the operations, excepting that by caustic, we might judge, I think, of the state of the testicle as soon as the water was wholly or in part evacuated; and if the testicle is found of its natural size, there will be no reason for apprehension about it; and if very much thickened, then the surgeon is to act accordingly. But I am inclined to believe that such diseases of the testicle as are generally attendant on dropsy of its coats, and are perhaps the causes of that dropsy, seldom do much mischief.

I cannot say I ever saw a cancerous testicle that began by pro-

ducing a common hydrocele, nor can I call to mind any case of common hydrocele, where the radical cure has been attempted, in which the testicle ever became cancerous afterwards. Yet I have known cases where it appeared a true hydrocele at first, and the testicle afterwards enlarged, and by degrees the water diminished, till at last the whole has been an enlarged testicle, and has been obliged to be extirpated. I have often seen the testicle diseased on opening the sac, and it has been generally thought proper in such cases to remove the whole; yet I imagine it is seldomer necessary than is thought. This disease would appear to be not sufficiently distinguished from cancer, to which I believe it has no real affinity; however, it is possible that cancer of the testicle may be attended with hydrocele. Perhaps this disease may have some connexion with scrofula, for I have seen scrofulous testicles, and have even extirpated them as cancerous. In some cases this practice is right, and it was so in those in which I did it, but it was not intentionally right; for although not cancerous, yet they often become so much diseased and so large that it is absolutely necessary to extirpate them. But still such have an advantage over cancers, as we may be pretty certain of the cure from the operation, which is not always the case where there is a cancerous disposition. If the case appear very dubious, I should recommend an incision, that the state of the testicle may be better understood, and the patient will be equally sure of a cure.

I shall now mention the causes of failure common to every method of cure, and then the causes of failure peculiar to each.

The sac containing the water being membranous, it only can be distended by the water which it contains, and readily collapses and throws itself into folds whenever this distention is taken off; and, as every method of cure requires the evacuation of the water, the membrane will collapse, if not prevented; and this collapsing I find to be the common cause of failure in them all.

It is a principle in the animal economy, when any natural internal cavity is exposed, that if any two parts of the cavity are brought together they will unite, but only at the edge next to the exposed surface; beyond this, if any two parts of the surface are in contact, they will not unite, being excluded from the necessity of union by the union of the edges which are nearest to the exposure. This part that does not unite then is formed into a cavity capable of containing a fluid, and of being hereafter filled in that way; where the sac has been large and not thickened, several such cavities may be formed, each capable of carrying on the disease. Until I understood the above facts, I could not understand why we have recurrence of this disease in the same tunica vaginalis. The first time I saw that a recurrence could take place was in a patient of my own, who died of small-pox whilst under the radical cure of the hydrocele. The recurrence of the disease will follow every method which does not prevent the two sides of the sac coming into contact with one another in the time of inflammation.

Of the causes of failure common to the Seton, Tent, and Caustic.—In either of these three methods of treatment, if the water is evacuated immediately, or is evacuated soon after the operation, at least before suppuration has come on, it often happens that the surface of the sac surrounding the orifices shall come in contact with the body of the testicle and adhere, which will immediately exclude all the other parts of the cavity from the necessity of inflaming, suppurating, &c., so that no union of the sac is produced but at the part. I have known a seton inclosed in this way along its whole course, and lying in a canal formed for it, instead of being loose in the general cavity.

I have known the same thing happen to the parts when the caustic has been applied: the edges of the sac all round have adhered to the testicle, so that when the slough has come away this has formed the bottom of the wound, which granulated; the wound filled up, the disease recurred, and required a second operation. I have also found sometimes, where the caustic has been used, that Nature has covered the inner surface of the eschar with new living matter, by which the inner cavity has been made perfect. A patient of mine had a hydrocele in each tunica vaginalis. I applied the caustic to each; when the sloughs came out, I observed at the bottom of each a bluish white surface, while the edges all round were red and granulating. This surface I suspected was the tunica vaginalis not affected by the caustic. I endeavoured to complete what the caustic had failed in; but was surprised to find that I was obliged to push my lancet in half an inch before the water came; when I introduced a tent to prevent its being wholly evacuated. I made a similar attempt on the other side; I introduced my lancet half an inch, and no water came, and I then made a puncture through the sound skin, and had not to go so deep as when the eschar had fallen out.

I suppose that when a breach or waste or loss of substance is produced in the outside of any cavity (and probably in every other part) there immediately takes place an irritation suitable to this cause, and this irritation produces an extravasation of coagulable lymph on the inside, to preserve the cavity or part as entire as possible, which it had certainly effected in this case. Probably this is the common cause of failure in the immediate effect of caustic, which was not before understood.

We see the same thing take place in joints; where that part of the bone which makes part of the joint becomes dead, we find a layer of coagulable lymph laid over the dead part or end of the cartilage, which preserves the joint perfect; otherwise the whole cavity must suppurate. In these cases of joints, as well as in the above, it has puzzled me to know how the layer of coagulable lymph was formed. If in either case death in the part did not go quite to the cavity, but leave a living surface, (no matter how thin, so as it is sufficient to produce a surface by extravasation,) we may then conceive how new matter may be laid on this surface and increase

to any thickness. If we can provide one layer, we can easily make it increase. It is a curious fact, and deserves attention. It is as if Nature was making the same opposition as we should do if a neighbour was endeavouring to make a way through the wall of our house, and, as we could not prevent his endeavours on that side, we should barricade further on this side, by raising up another wall.

To avoid these failures, I have practised and recommended that the tent or seton should be as large as the opening made for the introduction of it, so as to fill up the whole wound, and to allow but little or no water to escape, until inflammation and suppuration have come on; and in cases where the caustic has been applied I have not cut through the eschar, but allowed it to slough off, by which time the necessary inflammation has come on. This mode would seem to give the preference to the caustic; but we find Nature taking all the steps she can to frustrate our operations whenever they are violent upon her, as described above.

In some of the cases where the sac has collapsed and united as above described, leaving a cavity beyond it loose, it has happened that the preceding inflammation has gone too far for those cavities to remain in a quiet state, and suppuration has taken place in them while under cure, forming there an abscess which either breaks through the adhesions and opens into the first sore, or makes a new passage through the scrotum, like any other abscess, and a complete cure has been effected.

I have reason to believe that from the small opening made by these three modes, old hydroceles are sometimes deprived of the full effect of exposure; and that, though the parts inflame and suppurate, yet when the orifice has become small and taken on the closing process, the sac loses the suppurative disposition, (like the pleura when suppuration takes place,) the surface never having granulated, but simply secreted matter like the inside of a duct; and when the exposure ceases, falls back into the natural state, and the accumulation of water recurs.

When the radical cure is to be performed, either by tent, seton, or caustic, it is more proper to do it in one part of the tumour than another. One might at first suppose that the most depending part of the tumour would be the best, as in an abscess; but in fact it is the very worst, because here the inflammation is to follow the operation, whereas in an abscess the opening follows the inflammation. Why this should be a reason for performing it in a different part may not at first sight appear: but it is to be considered that the tumefaction attendant on the inflammation which is to succeed, will not be so great in the part where the operation is performed, if the extravasated juices, which are the chief cause of the swelling, can be allowed to depend; hence the opening will be less liable to close up when made at the upper part of the bag than at the lower, where it would be in the centre of the tumefaction, and would not allow a free discharge of matter, as we really see to be the case on many occasions. To avoid this

inconvenience, the opening should not be made at the lower part of the tumour; nor at the upper, for the following reason, viz., the water as it increases commonly pushes up the sac into the spermatic cord; therefore the situation of the upper part of the sac is changed immediately on the evacuation of the water; and the sac collapsing and contracting in proportion to the evacuation, its upper part moves downwards, which of course must alter the relative situation of the opening in the sac and in the skin. The opening should therefore be made in the middle of the tumour.

Of the Mode of performing the Operation with the Tent.—When the bag is pretty full of water, examine the bag carefully for the testicle. The situation of this being ascertained, grasp the bag in the hand, and squeeze the water towards that side where the testicle is not. Push the lancet in until the water comes out by the side of it, and then carry it forward, and enlarge the wound to about double the breadth of the lancet. Withdraw the lancet, but keep the tumour in the same situation, that the orifices in the skin and sac may continue opposite each other, or it will be almost impossible to introduce the tent; but do not press the sac quite so hard, or all the water will come out before the tent is introduced. Introduce the tent with the right hand, and hold it till it swells, when there will be less danger of its falling out. Then put on a piece of sticking-plaster, to secure the whole.

The tent may be kept in till the edges of the wound swell, which will be in a few days, and then the tent becomes loose, after which there will be no danger of the wounds closing up, for by this time the alarm will be given to the whole cavity, and the irritation of an imperfect part will be sufficient to prevent the wound healing. I recommend a sponge tent, as it swells and keeps the orifice perfectly open, and as this swelling is greater at the two ends than between the lips of the wound, by which two disagreeable accidents are prevented: the one, the escape of the tent into the cavity of the tunica vaginalis; the other, the escape of the tent altogether from the wound.

Of the Seton.—This is to be preferred to the tent, as being more easy to perform. The most easy method is with the common seton needle: holding the scrotum as above, introduce the needle perpendicularly where we know the water is; lower the end and raise the point, and bring it through the skin about half an inch or more above the other incision. Take off the needle, and apply a piece of sticking-plaster over the wound.

A lancet and eyed probe, carrying a skein of silk, is sometimes used, but it does not answer so well.

When suppuration is established, the seton may be either left in or removed, according to circumstances.

Of the Caustic.—A small caustic applied to the tumour is commonly sufficient to produce the effect, if it acts quite through the sac. In applying it, we should attend to the feelings of the patient, to judge when the sac is deadened by the action of the caustic.

The uncertainty of its acting through all the coverings of the sac has been an objection to this practice by many; and when it does fail in this way, the finishing what the caustic has not effected reduces the operation to the case of a simple puncture. I have before shown another objection also.

If the chance of the caustic not penetrating was the only objection, I should prefer the caustic to all other methods of cure for the following reasons: because it removes a small part, which gives a freer passage to the water than a simple wound; and we may produce the adhesive inflammation in the inner edge surrounding the slough before the water is evacuated, which in some degree determines the thickness of that part before the general tumefaction comes on. This gives it a considerable advantage over the puncture or seton, for they produce the general inflammation nearly as early as the local one, which proves inconvenient in many cases by thickening the scrotum at the orifice, which lengthens the passage and almost shuts it up. Besides, if the effects of caustic are produced quite through into the cavity, they excite the suppurative inflammation over the whole cavity before the water is evacuated, the presence of which more readily allows it to become universal. However, the caustic is not always a certain cure, even when its immediate effects are completely gone through, for I once saw a case where the seton had been used first, and on the recurrence of the disease the caustic was employed, yet after this there remained a small sac which required a third operation. The cause of failure in both the first was, I believe, that which I have before noticed of the edges of the opening collapsing and becoming united to the body of the testicle.

From what has been said it must appear that the great art in this operation is the prevention of the possibility of a relapse; to prevent which it is requisite that every part of the sac should be obliterated, for which purpose it is necessary that every part should be subject to suppuration.

I have now considered this disease, the precautions necessary before the operation, and the different methods of operating, with their advantages and disadvantages. I have endeavoured to show that every method hitherto recommended has in many instances failed, and I have also endeavoured to show the causes of their failure. It is proper now to consider of some method which shall not be subject to the above mentioned inconveniences.

I have of late used the following method of cure, with a view to producing universal inflammation and suppuration of the sac.

Make an incision into the sac about three inches in length, and let the whole of the water escape; then fill it as full as possible with pretty stiff poultice, occasionally introducing your finger to direct the poultice into every corner of the bag; and, lastly, put some lint into the wound to keep the poultice in. The poultice should be made of linseed meal, and pretty stiff; if it is made into little balls it will be still more convenient. The advantages

that this method has over the others are, first, that it is simpler than exposing the whole; secondly, the parts are kept universally distended by an extraneous body, so that the inflammation becomes universal; thirdly, the poultice does not become entangled in the granulations as dry lint does; fourthly, as the parts granulate and contract, the poultice is gradually squeezed out, and only requires superficial dressing during the whole time. With the same intention I have sometimes used lint dipped in oil or lard, which prevents its becoming entangled in the granulations, which without this precaution it is liable to do; so that I have known it retained in the sore for six weeks, when it was obliged to be removed to allow the sore to heal over.*

To prevent inflammation coming on too quickly and causing unnecessary pain, I believe it is right to apply a piece of linen cloth, folded ten or twelve times, and of sufficient breadth to cover the scrotum, first dipping it in brandy and squeezing it dry. Over this apply a suspensory bandage, which should be wetted as it becomes dry.

The symptoms following the operation are those common to all wounds, but as there is also a part in some cases concerned in this operation which has symptoms peculiar to itself, it becomes necessary to describe these; this part is the testicle. The testicle is only concerned when the collection of water is in the tunica vaginalis. The symptoms peculiar to it are in some measure those of a vital part; a dull heavy pain is felt, the stomach is sooner affected, and lassitude sooner produced, than in affections of common parts. Besides these, there is one peculiar symptom, that is, the pain in the back attending inflammation of the testicle. This is generally supposed to arise from the nerves of the testicle arising from the nerves of the loins. If this is the true solution of the case, we can only say this is peculiar to this part; therefore out of the common way of symptoms. In less than twenty-four hours the symptoms of the operation will begin; for, although the patient should have no pain, he will soon feel a lassitude, small short rigors attended with restlessness, which show that where this operation of inflammation is going on in the part, though it may not affect the senses, it is yet capable of producing considerable effects on the animal economy, so as very much to effect the vital principle. These symptoms increasing, the scrotum becomes sore to the touch, a greater degree of heat than common arises in the skin, the patient complains of thirst, and at last the diseased part becomes painful, swells, and throbs. The swelling is often very considerable; and, from the pain, this might be supposed to arise from the testicle, but it consists principally of the cells of the scrotum, which being composed only of cellular membrane, and that very ductile, gives way to the extravasated fluid, viz., coagulable lymph and serum. However, the testicle

* [Mr. Hunter afterwards substituted the use of flour, which he dusted over the exposed surfaces.]

itself swells and inflames in hydrocele of the tunica vaginalis, especially when that body is laid bare, as might be expected, as that part, or rather its coats, inflame and suppurate. Besides, we have the symptoms which denote affection of the testicle.

The future treatment is like that of common wounds, only a suspensory is required, as it relieves the pain in the back.

After the parts are healed, the testicle, for a considerable time appears hard and large, and the skin of the scrotum adheres to it. This gradually subsides by the contraction of the granulations, which are the chief cause of it, and by the absorption of the adventitious substance deposited by the inflammation. This natural process may be much accelerated by the use of the mercurial ointment, rubbed on the scrotum, for a month or six weeks.*

ON THE ACTION OF MEDICINES.

Before I proceed to make any further observations on particular diseases and injuries, I shall say a few words on medicines, or rather of their action on the human body.

* [There is one capital objection to all the operations above mentioned, which is their severity and danger. Many cases of death occurred, and many more of high constitutional irritation which placed the patients' lives in imminent peril. The operation which is now almost universally resorted to, and which is only cursorily alluded to by Mr. Hunter (p. 238), is free from these inconveniences, at the same time that it very rarely indeed fails of curing the disease. It was introduced by Sir James Earle, and consists in injecting the evacuated sac with any mild stimulating liquid, such as a solution of zinc, or equal parts of port wine and water, which are allowed to remain in from five to ten minutes, according to the feelings of the patient. A moderate inflammation generally follows this operation, and in a few days the fluid re-collects: after a short time, however, the inflammation subsides, and the fluid is absorbed. The time required for the absorption of the fluid varies from one to six months. Occasionally, but very rarely indeed, the disease returns.

It was imagined that this operation effected the cure by causing an adhesion between the opposite sides of the sac. An effect which is doubtless sometimes produced, and probably in all cases to a certain extent, although later observations have proved that universal adhesion of the sac is by no means a general consequence of the operation, which cures by destroying the morbid action of the secreting vessels in some manner which has not been explained. The success of this operation is not by any means in proportion to the quantity of inflammation produced, although a certain quantity seems necessary for the effect. The inflammation arising from injection rarely exceeds the adhesive stage; although this does sometimes occur. Only three cases of this kind are mentioned by Sir Benjamin Brodie as having occurred in his experience, and these three were West Indians, in whom suppuration took place. Occasionally the scrotum sloughs. (See *note*, p. 236.)

Where the operation by injection has failed, the operation by incision may be had recourse to. In children it is generally advisable to have recourse to the seton, using a few threads of silk only, passed by a common curved needle. In encysted hydrocele of the cord the same means may be adopted; or, what is still better, the sac may be laid open, and the fore part of it cut away. If it be situated on the testicle or epididymis, and of small size, it had better not be meddled with, or it may be simply evacuated, provided it is inconvenient to the patient from its magnitude. The operation by injection does not succeed in encysted as in common hydrocele.]

The living principle, I before observed, is susceptible of impressions which may be productive of action, either diseased or healthy, *i. e.*, productive of restoration; each of these may be brought on by medicine. Whatever affects the animal body otherwise than mechanically must be in a state of solution. From our juices being chiefly watery, the solution of many substances can easily be conceived; but they are likewise capable of dissolving earths, metals, &c.; nay, there is, I believe, hardly any substance which is not capable of being dissolved in the human body. Earth, and even iron, is found in animal substances on analysis, which must have been dissolved in the fluids, as well as essential oils, which may be detected passing off by our excretions. Taste is one proof of the power of our fluids to dissolve, for there is hardly any substance capable of stimulating but what will give a taste if applied to the tongue: thus, almost all metals held in the mouth for a little time will give a taste: the same thing most probably takes place with substances applied to the organ of smell. The blood, from its being so heterogeneous a fluid, may have its powers of solution inferred; and as I suppose a necessity of solution of these substances to affect the organs of smell and taste, so in like manner I suppose the necessity of solution, not only for its introduction, but for it to affect the system. Simple water possesses much less power of solution than when combined with some other substances; thus, by the addition of fixed air it becomes capable of holding earth in solution. From some similar combination perhaps the blood and other animal fluids derive their extraordinary powers of solution.

Medicines affect the living principle by their stimulant or sedative qualities only, unless they act chemically, as caustics; they have the effect of irritating or quieting, and these two contrary effects are generally to be found in the same substance, the difference resulting from the difference of quantity; thus, a small quantity of heat relaxes and softens, but a larger quantity will stimulate. A stimulus is what either causes a natural action, or increases one which has already taken place, or excites an action contrary to one present, as by giving an opiate when a patient cannot sleep, &c. Medicines may either stimulate or irritate; such as increase the natural power of acting are stimulants: such as excite new and unnatural actions are irritants. The powers of both will be according to the medicine and the parts combined, for fixed air in the stomach increases its action; in the lungs it destroys action.* The effects of medicine will be different according to the mode of action the parts are in at the time, that is, diseased, natural, or restorative. This is well illustrated by many diseases of the consti-

* [Sir Humphry Davy found that when he attempted to breathe pure carbonic acid the glottis spasmodically closed, from the *stimulant* action of this gas, so as to render further inspiration impossible; on the other hand, Foderé has remarked that a too free use of aerated waters will sometimes produce precisely the same effects as the inhalation of the dilute acid by the lungs, *viz.*, giddiness and intoxication.]

tution, as fever, &c., curing diseases in parts which had before been incurable; if the part had not been *diseased* the effect would not have taken place, for fever deranges a healthy sore.

Actions may be, first, of healthy parts; secondly, action produced by stimuli or irritants on healthy parts; thirdly, action of diseased parts: fourthly, action of stimuli and irritants on a diseased part. Irritants may produce very different effects on a healthy part, or whilst disease already exists; thus, mercury, by its irritation, will produce diseased action in a healthy part; the venereal poison, by its irritation, will also produce diseased action in a healthy part; but from the application of mercury to a part already affected with diseased action from venereal irritation, an action results different from that which would be produced by the application of it to a healthy part; for from the conjoined action of the two, results the action of health; but if carried beyond that it may do harm, producing its own specific action. Besides this, it is to be observed that the venereal action, or in fact any other morbid action, may produce a disposition for other increased actions, which may require only the absence of the former disease to allow it to come into action. These consequences are therefore to be distinguished from the original disease, otherwise the mode of cure may be continued too long, and that which might be curative of the first disease may increase the consequent one.

In a former part of the course I mentioned susceptibility, disposition, and action. Can the same medicine have an influence on all these? Will mercury, for instance, destroy the susceptibility and the disposition for the venereal disease, when formed, as well as the action? It will certainly destroy the latter, and we have cases which would make us think it will lessen the susceptibility also; but as to its having any effect in lessening the disposition I should very much doubt; but it may perhaps retard it.

A gentleman had a chancre, for the cure of which he used a large quantity of mercury, both by friction and internally, which produced very little soreness of his mouth. The sore at last healed, and from the quantity of mercury which had been used it was thought that the constitution was preserved; but in a little time discolorations of the skin appeared; for these he drank a quart of sarsaparilla daily, without their removal; on the contrary, fresh ones appeared. I gave two grains of calomel twice a day, and he was cured. Now I suppose that a disposition for this diseased action might have existed before the mercury was first used, which disposition was by this not lessened, but only retarded, and the cure did not take place until the venereal action took place, which was then cured by the action of mercury, the first mercury not preventing the disposition from forming; and it thus appears that what will cure the action will not cure the disposition, hence lues often requires repeated courses of mercury. The ultimate effect of impressions, I have already shown, are actions; and I also showed that diseased actions were thus produced; and here is the place to

observe, that in the same manner actions may be produced which are destructive of that which is diseased. But disease is not always the consequence of impression, but sometimes of imperfection of parts; thus, there may be a wasting of the body from a want of absorption of chyle from the intestines, or mesenteric obstructions. There is no impression without a counter-impression; as if one has a pain in the knee from a disease in the hip or loins; here it would be ridiculous to apply a remedy to the knee, as that is only the effect; yet this is often done.*

Medicines have visible and invisible effects. The visible may be divided into two, the constitutional and the local, the former producing the latter. The local are vomiting, purging, &c.; as an instance of the constitutional, the effects of mercury may be mentioned. Their invisible effects are commonly the specific effects, for we find that their curative do not always depend on their visible effects; and indeed their specific effects are often greater when they have no visible effect, as mercury producing salivation in the attempt to cure the venereal disease, bark in intermittents: but others cure by their visible effects.

Of Stimulants, Irritants, and Sedatives.—The two former are most commonly used by surgeons, because a want of disposition for restoration is more common than excessive wrong action; and a backwardness to heal is more apt to excite the idea of sluggishness than of excessive or wrong action, though perhaps even the latter may be the case. Medicines given slowly and continued long will produce effects very different to those produced on their sudden application, and thus it is that even stimulants and irritants may produce weakness.

On restoration of Action.—In the restoration of action of the whole body, or of diseased parts, attention should be paid to the strength of the parts, or of the whole system, for there may be too much action and too little strength, or too much strength and too little action. Strength and action should be well proportioned to produce good effects. When parts have lost their action for some time, they become weak, as we see in people recovering after drowning. If we do not attend to the degree of strength, we shall often produce irritability by hurrying on action too soon in weak parts. If a man is weak from loss of blood or from famine, his strength should not be tried by too much food, stimulation, &c. When strength exceeds action, then there is room for the use of

* [However unscientific this practice may appear, yet it is often found to relieve the pain, probably upon the simple principle of counter-irritation. If (it is argued) the knee sympathizes with the hip, why may not the hip sympathize with the knee? The principle is not very different upon which leeches are applied to the anus, and sinapisms to the feet, in affections of the head; that is, certain parts of the body sympathize with each other more readily than with other parts, and on this account are thought to afford the most favourable situations for counter-irritation; hence blisters to the knee relieve this part by first relieving the hip. The precise meaning of the term "counter-impression" in this connexion is not very apparent.]

stimulants. If the effects of medicines did not extend beyond the point of contact, their effects would be very trifling indeed; but their effects are extended much further by sympathy. This sympathy may be either contiguous, continuous, or remote. Such sympathies as are continuous and similar lose their power by distance only, and medicines acting thus may be termed local. But it is to be remembered that the remote sympathetic effect of medicines is not always the same as their effect on the part to which they were first applied. If the continuous sympathy was not similar, and if the effect of any medicine on any part thus affected was not continued by that same similar continuous sympathy through that part, how trifling would be the effect of such applications; and how could any application to the surface affect an inflammation which extends to a great depth but by the same sympathy? It is by sympathy that ether, applied to the forehead, relieves headache; applications to the skin of the abdomen, its contents, &c.; in short, if this were not the case no medicine could cure without coming in contact with every part of the diseased organ.

On the effects of external applications.—The commonly-received opinion respecting external applications is that they enter into the pores of the skin, and so reach the part; and on this idea practice was built. Parts were supposed to be relaxed and moistened by the joint effects of warmth and moisture, and on this idea warm baths were used to ruptures and dislocations. In many cases, indeed, very salutary effects were derived from their use; but this cannot be from the cause assigned, for the warmth of a living part is not thus increased; and a living part may be immersed for ever in warm water without becoming moister, except where the water is in contact. The good effects are produced by the external parts being soothed, and by sympathy the parts beneath lose their irritability, and the natural actions return. In suppression of urine the warm bath is often effectual; not surely because it penetrates from without, but because relaxation is brought on by sympathy. Volatile spirits and vapours have been used with the same idea, but it is well known that water will often penetrate where these will not. Oils are often used for the purpose of restoring stiff joints, perhaps from seeing their salutary effects on rusty hinges; but rusty hinges have greatly the advantage of the animal body, as oil will penetrate into every part of them and wash off the rust, whereas in a stiff joint not a particle of the oil will penetrate. The idea of their penetration has been carried so far as to lead some to prefer animal to vegetable oil, on the supposition that as it had come from an animal it would more easily enter an animal. Essential oils are used as stimulants in rheumatism, &c., but I suppose their effects are only produced by sympathy.

Although I do not admit of this mechanical penetration of substances, I have no doubt of their absorption by the action of the proper absorbing vessels: thus, mercury applied to the thigh is

absorbed and carried through it; but if rubbed on the bubo this can only be affected by sympathy with the skin.*

Pressure and Friction.—The ultimate effect of these seems to be similar, namely, stimulating, but from different causes. If pressure is used as a stimulant, it must be gentle: if violent, it will irritate, and produce vesication, as we see in bedridden people. Pressure produces increase of action, by first impeding action, the impediment acting as a stimulus on the part. Friction is more powerful, more active and immediate than pressure, and may be applied to larger surfaces; it does not impede action as pressure does at first, but rouses the parts into action, and excites a warmth in them. Stimulating or irritating medicines render friction more powerful in torpid parts. Fibres, by frequent rubbing, are stretched, and lengthen.

Heat, cold, and electricity produce effects not only at the part to which they are applied, but much deeper also. Water as it conducts quicker, is a better vehicle for the application of heat than air. Cold, when applied to the skin, has great and immediate effects. We have two opposite effects from cold-bathing, according to the mode of application and the state of the constitution at the time. By its quick and sudden application the power which the body possesses of forming heat is called up and exerted, and a glow of heat is soon felt on the surface; this is what takes place in a strong constitution; but if it is too often repeated in the same day, or the constitution is weak, instead of being refreshed, the person is more languid, is chilly through the whole day, the constitution not having sufficient power to restore the heat so suddenly abstracted.

Heat would seem to be produced in the vital parts; and it is to be observed that both birds and beasts have warmer clothing over their vital organs than their extremities, which abound more with oil, even in the bones. Action from the application of cold may be diseased, being sometimes the action of weakness; it may also act by sympathy, as cold applied to the back will stop a bleeding from the nose. Applied to the skin it will produce pain in the intestines, and a relaxation of the bladder. In a sprain it is common to pump cold water on the part, as it is supposed to produce action in old sprains. I believe it is not so plainly indicated, except where the constitution is sluggish.

Heat pervades all matter: the quality made evident to our senses is here meant; for the matter of heat is to be found more in some bodies than in others, though their sensible heat may be the same. Heat may be native or foreign: the latter I mean to consider here. Heat may be either stimulant, irritative, or sedative. It tends directly to increase action; cold, to lessen it. A case explaining

* [Later observations have shown that many of the phenomena of absorption are referrible to imbibition.]

my idea of the necessity of adapting action to the strength may be introduced here.

A child, with fever of the putrid kind and sloughs in her throat was very low and weak; she had taken bark, and had been blistered. I was called on account of a large slough appearing on the blister, to which I applied poultices, with opium. It was proposed to apply stimulating applications, which I objected to, on the idea that action had been already beyond the proportion which it ought to keep with the powers of the patient. The warm bath was likewise proposed, and on the same ground objected to; but it was tried, and my opinion confirmed, by the ill effects it produced. In fact, in such a case as this I should be careful of not increasing action too far; for as it is spared, so must the powers and the strength be preserved.

Heat is either applied in a dry or moist state; the first can only convey absolute heat to the part: water or bran in a bladder are the best dry applications. Electricity is the only application, perhaps, which can be said to penetrate, and its influence is very extensive.

On Diseased Dispositions and Actions.—I have formerly compared the dispositions of the body with the dispositions of the mind, and observed that dispositions were cured by actions taking place.

In some cases the action entirely destroys the disposition; in others it destroys it only for a time, but the disposition is renewed; in others the whole action never destroys the disposition, or if it does, the action goes on without the disposition, as if from habit, till stopped by some unnatural power, as medicine.

In the first case, where the action destroys the disposition, it is the action of restoration, as suppuration after inflammation. In the second case the disposition is destroyed for a time, or its power of continuing the action is destroyed for a time, but recurs again because the original cause, whatever it is, continues to exist, and is capable of renewing the disposition again, which again renews the diseased action. This is the case with all periodical diseases as agues, &c., and even some natural actions, as the menses. But whenever the constitution or part is capable of forming the full action of the disease, then that constitution or part is perfectly master of the disease, and it will seldom if ever prove dangerous, excepting it should produce some local effects in a vital part, as sometimes is the case of the gout. Let us take an ague as an example: it consists of three actions, which complete the whole, namely, the cold fit, hot fit, and sweat. If it stops in the cold fit, debility is either the cause, or it takes place; if it stops at the hot fit, strong action takes place which will probably prove a continued fever; if it goes through the third, then it is completed. It often happens that it is not able to form the hot fit, and, as it were, passes over it with sweat, which is cold and clammy, as if the discharge were not common sweat. But such cases approach to dissolution, for the sweat appears not to be the termination of dis-

eased action, but the termination of all action. Fits of all kinds, as epilepsies, are the same; they are a full action of the disposition; for such people shall be ill for days before the fit comes on, and after the fit they shall recover perfectly, only feeling a little weak from the exertion.

Of the third we have an instance in the lues venerea; for it appears, from experience, that it goes on increasing, till it is either cured or destroys the patient. (See *note*, p. 90.) Cancer the same, and probably many other diseases.

Of the first class there are many more diseases than we might at first imagine. Vomiting would appear to produce the cure of sickness; for sickness is the disposition; and the action, which we must suppose to be the ultimate effect, destroys the disease. Causes may produce a disposition, and that may bring on action at some distance of time, although health may intervene.

A young man applied a strong solution of corrosive sublimate for the cure of an itching of the pubis; by this application a violent inflammation was produced. I ordered a wash of lime-water, to decompose any part of the sublimate still adhering, and a poultice of oatmeal and lime-water to cover the parts, with tinctura thebaica sprinkled over it, which gave him much relief. This was continued two days, when I ordered him the bark, to diminish irritability; but the apothecary chose to give him an emetic first, which brought up a great deal of blood from the stomach, for which Dr. Heberden, who was called in, ordered tincture of roses; but this proved ineffectual. Seeing the patient dying, and well knowing the good effects of turpentine in stopping bleeding externally, I gave him two spoonfuls every two hours of an emulsion made with Chio turpentine; cold water clysters being also used. He continued for some time very low, and had scarcely any pulse, having lost so much blood; but he recovered, and got strong and fat. He now became dropsical, but recovered from this by the use, first of emetics, and then of squills and turpentine. Here the loss of blood produced not only debility but a disposition to dropsy, which disposition was not at first brought into action, and the patient got fat and well; but the disposition being at length brought into action he became dropsical.

It is on the same principle that many acute diseases cure chronic, the disposition being removed by a full action taking place. Should we not therefore attempt to induce this action for a permanent cure?

This practice is attempted in some obstructions to the full actions of natural operations, as in the menses: the period of attempt being when the natural effort is made, which is judicious. In intermittents, when there is not full action, perhaps giving a glass of brandy in the hot fit, and sudorifics to complete the termination, might be proper. At present this is only conjecture; but it shall be tried.

On the greater or less Disposition of different Parts to Heal.—Some parts of the body have a stronger disposition to heal in con-

sequence of common inflammation than others. Those parts which have the greatest powers sympathize most and inflame most, as the muscles, skin, and cellular membrane; but we must also observe that these parts have different powers in different parts of the body. Other parts have but little powers of healing, which may be owing to their natural want of powers as tendons, ligaments, bones, &c. These parts often lose their living principle, and be sloughed off, which is often salutary. The cellular membrane is common to different parts, and partakes of the power of such parts; thus, that connecting tendon to tendon has much less power than that of muscle. The sensation of those parts which are backward to heal is very different from that of the muscles and skin, as we should find on pricking them.

There is a difference in the power of healing, according to the age.—The diseases peculiar to different ages we have observed, some of which are specific. Those diseases which are common to all are less difficult to heal in youth than in old age. In youth the healing powers are much stronger than when that period is passed: and this is still more the case with regard to the powers of restoration than in the cure of diseases. Ages I divide into growth, rest, and decline. The powers of restoration may be ranged in the same order, and may be supposed greater in a child of two years old than in one which is younger, because it now has strength adding to its powers of growth, the increase of strength being in proportion to its growth up to a certain period.

One Disease often cures another.—We have observed that there may be universal sympathy with local affection; now this principle is capable of being reversed. One local disease often cures another, as hernia humoralis a gonorrhœa: and we have a local complaint curing a constitutional, but this local complaint is probably caused by the constitutional, the whole disease centering in one part, as gout, which I have called an act of the constitution. It is on this principle that blisters, setons, and issues are ordered; the former are useful, but from the latter two I have seen but little advantage. Constitutional diseases may cure local ones; the reason is, no part escapes the constitutional disease. I have seen fevers cure old ulcers, *noli me tangere*, &c.; which is done by destroying morbid action in the part; the local diseased action and the constitutional producing the third act, or health. Constitutional diseases sometimes cure themselves without taking on the complete action or crisis. When a local disease cures another (which is often the case) it must be by contiguous or remote sympathy, as headache by blistering the arm, gonorrhœa by swelled testicle, &c.; but I have seldom seen the second affection cured by bringing back the former. Local may be cured by constitutional, but may have reflected back on it the same disposition as that from which the constitutional action proceeds.

Of the Mode of Recovery.—As there is no disease but what has a peculiar mode of cure of its own, and every particular part a par-

ticular mode of curing its own diseases, it is necessary to see how far in this case Nature imitates natural principles. We shall first give the original or natural ones, and then show that Nature is always uniform in her operations, and when she deviates is still regular in her deviations. We may observe that a disposition is given at first to particular parts, and that that disposition continues in restoring their own properties, as cartilage grows cartilage, bone bone, &c.; but sometimes she changes the disposition, as the parts become adapted for different purposes, as where a joint is created at the end of an unreduced dislocation. Nature's adherence to her original principle may be exemplified by observing that in the regeneration of bone which was originally cartilage, as the long bones, there when a fracture takes place she begins by forming cartilage, but in the head, where the bone was at first membrane, there membrane is formed.

CHAPTER XVII.

INJURIES OF THE HEAD.*

Injuries of the head;—of four kinds;—concussion;—compression;—wounds;—want of due support.—Three first to be treated of;—symptoms attending all three.—Concussion.—Compression, from internal or external causes.—Wounds, and loss of substance.—Want of compression from loss of blood.—General remarks on fractures of the skull;—mode of examining them;—complications;—treatment.

INJURIES of the brain may be said to be of two kinds; one where the imagination is diseased, as madness, which probably arises from many different causes, which we have nothing to do with at present; the other, where it has suffered from some external or internal injury, which is mechanical. This mode of injury may be of four kinds: first, concussion; secondly, compression; thirdly, wounds, and loss of substance; fourthly, want of due compression, which last does not come within our present subject. To these may be added a consequent, namely, inflammation; but as this may arise from other causes, and is not always the consequence, it only requires to be mentioned. The first may be simple, that is, existing alone, or it may be complicated with one of the others. The first three kinds of injury will produce symptoms similar to each other, but very different from the fourth, as also from what may be called the fifth, or inflammation.

* [It may be observed that the lectures on gun-shot wounds have been omitted, in consequence of their great similarity, both in substance and arrangement, to Mr. Hunter's published opinions on the same subject. It was considered useless to repeat them under these circumstances, especially as they are less perfect in several particulars.]

The symptoms of an injury done to the brain can, I think, be but two, viz., an increase of imagination, or a diminution. The first is least frequent, and I should suspect arises from a slight cause rather than from a violent one, namely, such derangement as takes place in common madness, fevers, inflammations of the brain, &c., and which may arise from very slight compression.

The three first injuries will generally give the appearance of too much repletion. The muscles about the mouth and throat become flaccid, hence laborious respiration; and as respiration must go on, a kind of rattling in the throat is produced, which often works up the saliva into a froth. But all these symptoms will be in proportion to the injury done, and perhaps many other circumstances. The fourth will produce an insensibility, attended with restlessness similar to convulsions or fainting; and I suspect that the fifth produces a delirium, if but in a slight degree. In all cases of affection of the brain, sympathy takes place in the stomach, which produces vomiting; but I believe that in order that this symptom should take place it is necessary that the senses be not entirely gone, for those who are struck perfectly insensible, I believe, do not begin to vomit till they begin to recover in some degree their senses.

Sometimes erysipelatous inflammation of the head arises, and then the patient often feels violent headaches, sometimes approaching to delirium, rigors, &c. In these I suspect that the brain is in some degree affected with the same inflammation, therefore the symptoms are not to be attributed to the immediate effect of the blow.

Concussion is always from some considerable violence. It may arise from some degree of displacement or alteration of the texture of some part of the brain, so as to destroy the arrangement on which health, sensation, &c., depend.

Compression may arise from accident, or from many other diseases. Those arising from accident may be either immediate or secondary. Immediate, as when a piece of the skull is beaten in upon the brain, or a blood-vessel ruptured, producing apoplexy. The secondary is from slow extravasation, as from inflammation, or the formation of pus. Compressions arising from disease will always be the immediate effect of that disease. They may be said to arise from eight causes; two of which may be called external, the other six internal. The two externals are, when the brain is compressed either by the skull being beaten in, or from the thickening of the bone by disease. The six internal causes are: first, distention of the ventricles by water; secondly, distention of the blood-vessels of the brain; thirdly, inflammation; fourthly, formation of pus; fifthly, extravasated blood, as in apoplexy; sixthly, tumours in the substance of or on the brain.

Wounds or loss of substance are somewhat similar. When the substance of the brain is broken in upon, loss of substance may or may not be the immediate effect of the violence. It is the immediate effect, when part of the substance is carried off by the violence;

but the consequence, when a part is lost in consequence of an opening being made to take off any fluid that is pressing.

The fourth species, where there is want of due compression, arises from large bleeding, or where the water is let out which the brain has been accustomed to bear, as in hydrocephalus or spina bifida, which are rare, and which are out of the power of surgery.*

Whichever of the three first species of injury takes place, the effects are nearly the same, if the degrees are the same; and whatever are the causes of compression, the symptoms are the same.

If we only know that symptoms have arisen in consequence of violence, then it is necessary to know the date of the violence, that we may know whether the symptoms are the immediate or the secondary effects, or both; for they are often attendants on one another.

The symptoms of concussion, if slight, are always the immediate effect, that is a more or less immediate loss of sense, &c., which is proportioned to the violence done. Under certain circumstances, the effects of concussion will be more violent than what belongs to the injury itself; for a man who is drunk may get a blow on the head which, joined with the effects of the liquor, will produce violent symptoms, and may lead the surgeon to do more than is necessary. Therefore it is better to wait until the drunken state is gone off, and the effects of concussion left pure.

When there is depression of bone or extravasation, the symptoms of concussion are lost, though it may be at the bottom of all. If the symptoms of concussion have kept up eight or ten days, we may expect extravasation has taken place; if three or four weeks, suppuration. We may know whether the symptoms are caused by blood or pus, by their going off entirely and then re-appearing. If they come on soon after, it is blood; if not for a week or so, it is probably pus.

A gentleman for two years after receiving a blow on the skull was delirious. I felt a little depression, and applied the trepan, and took out a piece of bone which had been depressed all this time, part of the internal table of which was absorbed, and pus was lying on the dura mater.†

* [Modern experience has shown that both these diseases are capable of relief from surgery. The operation of drawing off the water, when performed under favourable circumstances and with proper precautions, holds out a reasonable hope of success, and has effected a cure in several cases.]

† [The great importance of injuries of the brain may justify a few observations in this place, for the purpose more especially of pointing out the distinction between the symptoms of concussion, compression, and lacerations of the brain, which is a part of the subject which has been only slightly adverted to in the text. Indeed, Mr. Hunter has said that these "three kinds of injury will produce symptoms similar to each other."

1. *Concussion*.—When a severe injury is inflicted on the head, the patient is instantaneously deprived of volition and the power of voluntary motion; the pulse becomes feeble and intermittent, and the whole system labours under a remarkable depression, approaching to a state of syncope. After a few minutes,

General Observations on Fractures of the Skull.—Fractures of the skull may be divided into three kinds, and these are sometimes

or perhaps several hours, the patient recovers his consciousness; the action of the heart is re-established; the sickness, with which he was at first affected, passes off, and nothing remains but a severe headache, which may last for several days as a solitary symptom, or else recur at different intervals, upon any occasional excitement.

These effects of concussion may of course be variously complicated with wounds of the scalp and brain, compression of the brain, and fractures of the cranium; but very often these complications do not exist; and yet after death no perceptible lesion of the affected organ can be detected, except perhaps a separation of the dura mater from the internal table of the skull, or the extravasation of blood in minute specks in the substance of the brain. In the severer forms of concussion, indeed, the brain is generally lacerated in one or more parts, from whence it is reasonable to suppose that disorganization of a less palpable and extensive kind is also produced in the slighter forms, although it is not capable of being detected by the eye.

Now it is observable, that although one of the first effects of severe concussion is complete insensibility, yet this state is soon followed by one in which the sensibility is only impaired, so that it is not difficult to rouse the patient by any sudden and strong impression. Upon being roused, his manner is generally peevish, obtuse, and incoherent, and he instantly relapses into his former state of tranquil lethargy, as soon as he is left undisturbed. There are no indications of paralysis: the pupils contract on exposure to light; the pulse, which at first was exceedingly feeble, now rallies and rises above the natural standard; the circulation is easily accelerated upon the slightest exertion, and there is very generally an intense headache, which becomes proportionably more severe as the reaction of the circulation takes place and the sensibility returns.

The dangers attending this species of injury are twofold. The first arises from the state of collapse immediately following the injury, which may be so considerable that the constitution is not able to make any effectual effort to rally from it. The second arises from the inflammation which may afterwards ensue. Cases of the first description are of rare occurrence and only require that the surgeon should bear in mind the possibility of such an event, in order to guard against it by the administration of cordials whenever the necessities of the case seem to demand these aids to reaction. The danger of inflammation is much more formidable, and will be in general in proportion to the severity of the first symptoms and the rapidity and violence of the reaction. Other circumstances, however, will exercise an important influence on this event, as, for example, the separation of the dura mater from the cranium; the existence of disorganization or rupture of the minute structure of the brain; the denudation of the pericranium from the bone; or the patient's being in a state of intoxication at the time of the accident. These circumstances will greatly increase the dangers of his situation, and require a more vigorous adoption of such measures as are calculated to avert inflammation. At first, when the reaction of the heart has taken place, the patient should lose a considerable quantity of blood, so as completely to subdue the force of the circulation; afterwards, for the most part, it is only an occasional bloodletting which is required, and that to a moderate extent. These measures should be assisted by perfect repose of body and mind; depleting and cooling medicines; cold applications to the head; a spare diet, and a raised position of the head and shoulders, which should be persisted in more or less for several weeks, even although all apparent effects of the injury have disappeared. It is unnecessary to observe, that the old practice of applying the trephine in such cases is in the highest degree pernicious, and cannot possibly answer any good object.

The occurrence of secondary inflammation, at the end of four or five days to as many weeks, should be jealously watched for, and instantly combated by the most vigorous depletion. Such cases generally terminate unfavourably; but

complicated with one another: first, when the external table is beaten in; secondly, fissures; thirdly, when the bone is broken off

happily they are of less frequent occurrence than they were formerly, in consequence, it may be presumed, of the steady antiphlogistic measures which are now almost universally resorted to in the first instance. When, however, these symptoms arise, followed by rigors and the evidences of compression, attended at the same time with a puffiness in some point of the scalp, or a glassy unhealthy state of the wound, if there happens to be one, then the application of the trephine, to let out the matter which is collected between the dura mater and the skull, is justifiable, and ought not to be delayed. Still it must be evident that this operation will be unavailing when the matter is effused on the interior of the dura mater, which very frequently happens in such cases.

2. *Compression*.—The enumeration of the causes of compression by Mr. Hunter will probably be found to include every possible variety; yet it is to be observed that compression produces different effects, according as it is gradual or sudden; in the substance or on the exterior of the brain; in one spot or diffused over a large surface; or as it is situated at the inferior or superior part of this organ. The slow encroachment of a tumour on the brain does not so suddenly rob the patient of his faculties, as a portion of the cranium suddenly depressed by accidental violence; neither is it of common occurrence for sanguineous effusions on the surface of the brain to produce hemiplegia, although this is one of the most frequent symptoms of apoplexy arising from spontaneous effusions into the substance of this organ. "There is reason," Sir Benjamin Brodie observes, "to believe that pressure is on the whole more dangerous when it affects the lower part of the brain than when it affects the upper part; and it has appeared to me that more urgent symptoms are produced by a given quantity of blood when it is effused into the cells between the tunica arachnoides and pia mater than when it is collected in one mass so as to produce a less general pressure." In speaking, therefore, of the effects of compression, I would wish to be understood as confining myself to that form of the affection which arises from accidental violence.

It should never be forgotten that the blow which occasions a fracture and depression of the cranium or an extravasation of blood is likely to produce concussion also, although, as Mr. Hunter has remarked, the symptoms of concussion in such cases will be proportionally less severe, as the cranium has yielded more readily to the cause of fracture.

The leading symptom of compression of the brain is insensibility, which is generally much more complete than that which arises from concussion, and more nearly allied to that of apoplexy, with which in other respects the symptoms of this accident closely correspond. The pulse is oppressed and slow; the pupils are dilated and immoveable; the respiration is slow and stertorous; and the voluntary muscles are paralysed. Sickness and vomiting do not usually occur, at least in the worst cases, until the cerebral symptoms have undergone some mitigation, and it is observable that the symptoms all disappear the moment the compressing cause is removed, which explains why a copious venesection shall frequently produce a temporary but fallacious amendment. When these symptoms arise from depression of bone, they show themselves immediately after the infliction of the injury; but when they depend on an extravasation of blood, a longer or shorter interval elapses before they come on, depending on the rapidity of the effusion, which will in general be greater in proportion to the celerity and violence of the reaction from the first impression of the accident. Not unfrequently, therefore, the first insensibility is produced by concussion, then the patient recovers, and then relapses again upon the effusion taking place. In other cases, the insensibility, which was only partial at first, gradually terminates in complete stupor, corresponding to the gradual manner of the effusion; in other cases, again, the patient does not recover from his insensibility until inflammation has set in, and then the two sets of symptoms are confounded together. In short, the symptoms of compression not only vary in degree, but as

into a loose piece. I have also been told of a case where the symptoms of an injured brain arose, but the skull showed no frac-

they happen to be complicated with those of other injuries of the brain ; and it is worthy of remark that the same amount of compression gives rise to symptoms of very different degrees of severity in different cases ; while of two individuals in whom the early symptoms appear to be equally urgent, one may die in the course of three or four hours, and the other may survive for several days ; in one the symptoms may wholly subside in the course of a day or two, and in the other continue, at least some remains of them, for several months or even years. Sir Astley Cooper, for example, has related an extraordinary case, in which a total loss of volition and voluntary motion continued for upwards of thirteen months, on which Mr. Cline afterwards operated successfully by removing a depressed portion of bone, which restored the young man to the perfect possession of his intellect in the course of four days.

But compression may give rise to other symptoms besides those which have been mentioned, as, for example, pain in the head, general convulsions, furious delirium, partial paralysis of particular muscles or sets of muscles, and various states of the pupil. The pupils, as I have already mentioned, generally remain permanently dilated ; sometimes, however, they remain permanently contracted, or contract and dilate as usual, although in other respects the patient may be in a complete state of insensibility. Dr. Hennen has related a case in which the admission and withdrawal of light operated differently to what it usually does ; and Sir Benjamin Brodie has referred to cases in which the two pupils were in opposite states, or in which they dilated and contracted independently of light and darkness. The loss of one entire class of sensations, as of speech, smell, taste, hearing, or sight, is not very uncommon ; or the affection may be even still more partial, as, for example, a ptosis of one eye, a paralysis of one arm or one side of the face, the destruction of the sexual powers, or the loss of memory, which may be either of recent or of remote events. In some of these cases dissection has disclosed some local cause of pressure, while in others the removal of a depressed portion of bone has immediately removed the symptom, so as to leave no doubt on the mind as to the real cause which produced it. In many instances, however, it is only possible to offer a conjecture, derived from general analogy and the particular circumstances of the case, guided by the knowledge which we possess of the functions of the different parts of the brain, from all which it would appear probable that these partial lesions are sometimes due to disorganization of, or pressure on, certain districts of the cerebrum, from whence the nerves to the paralysed parts are specially derived. However, as Sir Benjamin Brodie has remarked, " it is difficult to conceive that pressure on the brain should exist in so great a degree as completely to destroy a complete class of sensations, and at the same time be so partial as not to affect any other function of the nervous system. On the other hand, it is also difficult to regard these as the effects of concussion of the brain, since it is one of the characteristics of concussion to produce no more than a diminution of sensibility, and that diminution, instead of continuing for months or years, is completely relieved in the course of a few days, and probably in a much shorter space of time."

The most common situation in which blood is effused in accidents of the head is between the dura mater and tunica arachnoides, especially towards the base of the brain. It may occur, however, between this last-mentioned membrane and the pia mater, or between the pia mater and the brain, or in the substance of the brain itself. It may also occur between the dura mater and the cranium, whenever the connexion between these parts has been destroyed by the violence of the injury. It is, however, to be observed that considerable effusions of blood rarely occur in this last situation, except when the cranium has been fractured in the direction of the middle meningeal artery, and the artery has been ruptured in consequence.

The treatment of compression arising from depression of bone will be spoken of in a future note ; but where compression arises from extravasation of blood,

ture or fissure; and on removing a portion with the trephine, the inner table was found beaten in, the external table being perfectly

the same general principles must be followed as in cases of concussion, both to prevent any further effusion and to obviate the danger of inflammation. The question however arises, whether any operation can be beneficial for the purpose of giving an exit to the effused blood? In answer to which it may be replied, that as a general rule no operation can be beneficial in these cases, both on account of the difficulty of ascertaining the precise seat of the effusion, and the impossibility in the great majority of cases of reaching it when it is discovered. When, however, a blow has been inflicted over the meningeal artery, and the symptoms of compression are not only not relieved by venesection, but gradually become more urgent, it will be extremely proper to give the patient the chance of the operation, which will also be proper in other cases where the seat of the injury is well marked and the stupor is hourly becoming more alarming. Unquestionably it would be unwise and unwarrantable to resort to an operation too hastily, but under the circumstances which are supposed an operation will scarcely be supposed to add much to the danger of the case, at least the operation of dividing the scalp in order to ascertain whether the bone bleeds freely, or whether there be any fracture. If the bone does not bleed so freely as it ought, or if there be a fracture, these are justifiable grounds for perforating the cranium; and the surgeon will be further justified in puncturing the dura mater if he finds an accumulation of blood beneath that membrane pressing on the brain. It ought, however, to be remarked, that it will always be expedient to remove the cranium extensively whenever the trephine is resorted to for this purpose, or for affording an escape to pus, as without this is done only half the benefits of the operation will be obtained.

3. *Wounds of the Brain and Membranes.*—The peculiar danger of wounds of the brain and its membranes arises, in the great majority of instances, not so much from the immediate effects of the injury as from the extensive and intractable inflammation which afterwards follows, giving rise to effusions of pus, disorganization of the substance of the brain, and hernia cerebri. When the head receives a severe concussion, the brain is liable to be lacerated, particularly towards the base, in consequence of the inequalities of the cranium at that part; and the symptoms in such cases will necessarily be complicated with those of concussion as well as with those of compression: but when the brain has been simply incised or punctured, very often no symptoms whatever arise to indicate that the bodily or mental functions are in the least degree impaired; indeed this absence of symptoms is sometimes very remarkable, and extends to cases in which considerable portions of the brain have been lost, or foreign bodies been lodged in it. Wounds of the brain, however, are always dangerous, and it is not to be supposed that there can be an extensive destruction of a part so important as the brain without immediate death, or death in the course of a very few hours. A confusion of intellect beyond that which simple concussion usually produces, and twitches of the muscles of the extremities, are diagnostic marks by which (as Sir Benjamin Brodie has observed) these cases may sometimes be distinguished. The same author also observes: "I have not been able to discover, among all the works which I have consulted, a single instance of recovery from a wound of the posterior lobes of the cerebrum, of the cerebellum, or medulla oblongata; and in the great majority of cases in which a cure has taken place, the injury has been confined to the frontal bone, and that part of the brain which is covered and defended by it."

It is unnecessary to observe that the general principles of treatment which have been already pointed out are equally applicable to wounds of the brain, and must be persevered in with the most watchful assiduity. The local treatment resolves itself into the management of fracture, which will be considered in an ensuing note. I shall only, therefore, further observe, that the most judicious surgeons of the present day unitedly concur in the wisdom of forbearance, and in not attempting to extract foreign bodies, unless this can be done with the most perfect facility.]

sound. I have seen several instances where the external table was beaten in, and the inner table not hurt.* Depression of the external table may be complicated with extravasation or concussion, and may become the cause of extravasation or of the formation of pus. Fracture may be complicated with fissure, that is, fissures often run from the fracture a very considerable way along the skull. Where the external table only is beaten in, it is owing to the medullium being thick and spongy, and allowing the external plate to sink into it. This is generally done by a small instrument with a good deal of velocity, as the edge of a horse's shoe. Every violence that can produce complete fracture must cause more or less depression, though it may not be very visible; and sometimes, if the force has not been very great, the piece may be returned again into its position immediately. Besides, the inner piece is always broader than the point where the violence has been applied on the external. All fractures of the skull may be called compound; for if not so naturally, they are made so by the removal of the scalp. They differ widely from fractures in general in other parts, as healing the parts is only necessary in fractures of other bones, but here we have to prevent the mischief arising from the broken bone to parts essential to life.

Fractures of the skull of themselves produce no symptoms respecting the brain, only those of a broken bone; but when they are complicated with other effects, then symptoms arise accordingly, more or less according as the fracture is greater or less. There may be bleeding at the nose and ears when the fractures must be running over these parts, but they may occur without a fracture of these parts, and there are symptoms of other injury besides fracture. When complicated with concussion, the symptoms of this will be less according as the fracture is greater, for it is from the bones not giving way easily that the head is violently and quickly moved so as to produce concussion. These effects will be according to the weight and velocity. When the weight is great and the velocity small, we shall have more concussion than with a small weight and great velocity: hence from gun-shot wounds we seldom have any concussion.

In cases of fissure only it may admit of a dispute whether we are always to trepan. If there is no symptom of an injured brain,

* [Dr. Hennen has given an account of a case in which the internal table of the skull was splintered, and at one part driven more than half an inch into the membranes of the brain, although there was not even a fissure of the external table. Cases of a similar kind are preserved in almost every museum, and are easily accounted for by the greater brittleness of the internal table. Of course the same cause will produce similar effects in ordinary cases, so as to render it impossible to ascertain the actual amount of pressure which exists in any given case from mere inspection of the external fracture. In children the bones generally are more tenacious than in adults, in consequence of containing less earthy matter. Hence the cranium may be depressed or indented in them without being fractured, just as a tough or green bough will yield to a force in a very different manner from a dry stick.]

certainly it will not be necessary. It may not be necessary even when attended with symptoms of an injured brain, for the injury may only be from the concussion, and we never trepan in a concussion. However, as we cannot tell for certain at the time whether the symptoms arise from concussion, compression, or from extravasation of blood, it may be more advisable to trepan, as the operation can do no harm. In cases of depression of the outer table it would also be unnecessary to trepan; but it will be impossible to say that it is certainly a case of this kind: for, though there may be no symptoms of an injured brain, there may be depression of the inner table, which may do mischief afterwards. In young people there may be fracture with depression which may cause no bad symptom at the time, but as the patient grows up bad symptoms may arise, probably from this cause, that there is not sufficient room for the natural growth of the brain.

In all cases of violence attended with compression, either from fracture or not, the trepan is absolutely necessary; but we cannot always promise relief from the operation, nor can we always apply it where it is necessary. When compression is by bone, and its situation known, and the situation is a proper one for trepanning, there is no difficulty; but when the compression is by blood or pus, and there are no external marks of violence, then it is more puzzling. However, rather than let the person die, one would trepan somewhere or other; and if this did not answer, one would not stop here: for I have seen a collection of matter on the opposite side to that on which the blow was inflicted; yet this is a case where one would promise but little encouragement, there being but little chance of success.

Even when we have external marks of violence to guide us, and do trepan, yet this is often not sufficient to free the patient from the compression, for these fluids are often formed between the dura mater and the brain when none is found between the skull and dura mater. The dura mater must not, however, be perforated without good grounds; we should be as certain that there is fluid contained under the dura mater as we were certain of the necessity of applying the trepan in the first instance. In all cases where I have seen the dura mater wounded, it was by a crucial incision, and the patients have all died. When it is necessary to open the dura mater, I would recommend making a simple incision, for this would be more likely to heal by the first intention, and we could then move the edges to one side, and see if there were any injury below. Whenever I have seen the dura mater opened, the brain has worked through the opening, and the patients have died.* This was the

* [As hernia cerebri may occur simply from the support of the cranium being removed, it will *à fortiori* be more likely to occur when the dura mater is removed also. I should remark, however, that hernia cerebri does not necessarily ensue under these circumstances.]

It may be proper to observe, that the treatment of this disease consists in the

case with a Mr. Cooper, whose dura mater I opened with a crucial incision on account of the state of parts beneath: he died, and I think it is probable I killed him, by opening the dura mater. Patients, under these circumstances, might probably have died, independently of the opening, but this I think would certainly kill them.

Fractures very rarely run through the base of the skull where operations cannot be performed; but if the bones of the base of the skull are only fissured, it will be of sufficient service to trepan on the fissure as low as we can follow it. I have trepanned once below the insertion of the muscles of the neck, and with success.

Trepanning on sinuses has been condemned, but it can do neither harm nor good if the blood is between the dura mater and pia mater; if there is only a depression on them it can only obstruct the sinuses, and not affect the brain.

An incision is sufficient to examine for a fracture if made sufficiently long; and if a fracture is found, it is to be followed to its full extent: but where it is found necessary to trepan, it will be proper to remove the scalp, and do it freely, for an operation should have no incumbrance which we can prevent. We should scalp carefully, lest there should be some loose pieces of bone underneath which we cannot see, by which otherwise we might plunge into the brain; and yet I own I cannot always call to mind this caution at all times when operating.*

It has been recommended lately, after trepanning, to put the scalp down again, and unite it by the first intention; but I doubt whether we should be able to bring the angles perfectly together; and if not, part of the dura mater must be exposed, and must suppurate.

A fungus is very apt to arise from the dura mater. Why this should be more than from any other part I cannot say.

A poultice is the best application after either scalping or trepan-

judicious application of pressure until the fungus is repressed below the level of the dura mater, which then heals over it and prevents its reproduction. This plan generally succeeds, although the old method, consisting in the removal of the surrounding bone, or of the fungus itself, almost invariably failed.

The danger of hernia cerebri being formed when the cranium is removed may justly be urged as an argument for not having recourse to the operation of trephine without the most satisfactory reasons, to which may be added, the still more alarming risk of inflammation and sloughing of the dura mater from accidental violence inflicted by the trephine, or from the mere effects of simple exposure. The fact also of a portion of the cranium being left undefended after the recovery of the patient, should not be neglected in estimating the dangers of this operation, which unquestionably are very considerable.]

* [It is impossible to help being struck with this confession, so characteristic of the love of truth and candour which Hunter possessed. Indeed, the same remark appears to me to apply to all the preceding observations, in which may be traced a hesitation and forbearance of judgment uncommon to the author, as if he had not fully approved of the existing rules of treatment, although he had not yet gone to the extent of substituting others in their stead.]

ning, because it always admits of immediate removal, and keeps parts in an easy agreeable state.*

* [No part of surgical treatment (with the exception perhaps of aneurism,) has undergone such important amelioration as that which relates to injuries of the head. Whoever will look into the writings of the period when these lectures were delivered will be astonished at the officiousness of surgeons in counteracting the restorative efforts of Nature by their rude interference, and converting into complicated wounds what were simple in their origin. Hunter was unquestionably less infected with this evil than most of his contemporaries, but still we cannot but observe the influence of this spirit in the directions which he has laid down for the treatment of fractures of the cranium, for which reason it will be necessary to guard the reader against drawing false conclusions on this important subject.

The propriety of these observations will be apparent from considering the cases in which Hunter thought the application of the trephine was justifiable, viz. 1, in young children in whom there was depression without symptoms; 2, in cases of depression of the outer table only; 3, "in cases of fissure only it may be more advisable to trepan, *as the operation can do no harm*;" 4, "in all cases of violence attended with compression, either from fracture or not, the trepan is absolutely necessary," and if blood is not found on one side, to trepan on the other; and lastly, in fractures of the base of the cranium.

Now it is to be observed that there is as much, if not a much greater, difference between simple and compound fractures of the cranium as there is between simple and compound fractures of the thigh; consequently, nothing can be more unadvisable and rash than to convert a simple fracture into a compound one, unless the urgency of the symptoms is such as imperatively to demand interference.

In regard, therefore, to simple fractures of the cranium, it may be laid down as the general rule of practice never to interfere without the strongest reasons for so doing, nor even then until a reasonable time has been allowed for the symptoms (which may depend on concussion,) to subside, and depleting measures been freely employed. Under such treatment the symptoms will often disappear after a short time, and the dangers of subsequent inflammation be infinitely lessened. Nothing surely can be worse than the attempt to *anticipate* the symptoms of compression by resorting to the trephine.

And in regard to compound fractures of the cranium the same rule is to be observed. If there are no symptoms, the surgeon should desist from any interference, and endeavour, to the utmost of his power, to procure union by the first intention. If, indeed, the depression is very considerable, it may be advisable to elevate it, although there are no symptoms at the time; but if there are symptoms, it will be right and proper to do so in all cases. The same principle should guide the surgeon in the extraction of splinters of bone and foreign bodies, and restrain him from making the attempt unless his object can be accomplished without adding to the irritation of the injury. It is scarcely possible to imagine a case in which an operation so near the basis of the cranium as the author has described can answer any useful object.]

CHAPTER XVIII.

OF THE DISEASES OF BONES AND JOINTS; OF FRACTURES, DISLOCATIONS, ETC.

Bones liable to all the diseases of soft parts.—Death of bone.—Caries.—Diseased actions;—ulceration;—induration.—General treatment of diseased bones.—Accidents to bones; simple fracture;—principles of treatment;—period and mode of union;—false joints.—Inflammation of bones;—treatment.—Suppuration of bones.—Compound fractures;—treatment;—communicating with joints.—Question of amputation.—Fracture of patella, olecranon, and outer ankle.—Suppuration in bones;—spina ventosa;—necrosis;—treatment.—Of the contraction of diseased joints.—Sprains;—treatment.—Dislocations;—observations on their reduction.—Formation of new joints.—Accidents and inflammation of joints.—Loose cartilages.—Anchylosis.—Diseases of joints.—Wasting of muscles.—Exfoliations and necrosis;—treatment, by actual cautery.—Extraction of sequestra.—Rickets.—Mollities ossium;—treatment.—Exostosis;—treatment.—Exfoliations of cartilage.

BONES have been very much considered separately from other parts in their growth, structure, and diseases. Bones being less subject to changes after death than the soft parts, are therefore more favourable for the explanation of their diseases after death, such as ulceration, tumours, &c.; and diseased bones of all kinds may be picked up in church-yards.

The bones, in their causes of disease, in many of their diseases, in the terminations of these, and in their restoration, are similar to the soft parts. They are susceptible of the different inflammations and their consequences, but they are more backward to heal, forming fistulas; in their specific diseases also they resemble the soft parts. But, unluckily for bones, they can hardly swell; nor can their coverings swell without its being immediately suspected as venereal, so that mercury is often given to the detriment of the patient. Nor can they require a different treatment, as regards their vital power, from the soft parts, though they may in the mechanical part; but it will be found that they require a different mechanical treatment only in consequence of their solidity. The hardest bones are most liable to venereal affections; the softer to scrofula; but the surrounding parts very often partake of their diseases for very wise purposes. Their diseases do not so readily recover as those of soft parts, as the restoring powers are much more weak and tedious in their operations. This slowness is probably owing to an indolent disposition and weak powers. This may, in some measure, arise from the earth in them being a part not possessed of the living principle; yet we find that the hardest bones are cured the soonest; but this is when there is exfoliation, which shows they are more ready to die, and, consequently, to exfoliate.

Their diseases are often very serious, in consequence of our ignorance of the extent of disease, as well as of its nature; for though, from an increase of size or a fistulous opening, we may know the bone to be diseased, still we obtain very little information as to its nature.

Death of Bone.—Bones often lose their life from becoming detached, and their surface being either exposed to the air, or to matter surrounding it. The reason of this is, that bones receive most of their nourishment from the surrounding parts, as from the periosteum; therefore it is natural to suppose that the surface at least will become dead when this part is removed. This may be observed on the projecting end of a stump. The harder the bone, the more ready it is to lose its vital principle by exposure. Sometimes the external surface dies easier on being laid bare than the internal: this is the case in the skull; the external will often exfoliate without the internal.*

Caries.—Death of the exposed surface makes a material difference in the appearance of ulcers of the bone, and they have been classed accordingly. In one case surgeons found the surface of the bone dry; in others moist, and covered with matter; hence the distinction of dry and moist caries; but this arose from ignorance of the disease. When the bone is entirely dead, then there is dry caries; but in the moist the bone is inflamed and ulcerated, and furnishes a discharge, not being dead. When it was perceived that the dry caries only exfoliated, the actual cautery used to be applied on the idea of drying the moist caries; but this was done without knowing the principle on which it was done, viz. that of entirely destroying the life of the bone. By caries I should understand a rotten bone, and by a rotten bone a dead bone. But the distinction between a diseased bone and a dead bone has not been sufficiently attended to, for the term caries has been commonly applied to a bone in the state of an ulcer, and also to a dead bone. Now a disease must always be in a living part, whether soft or hard; but the same term applied to the two different states of bones can give no just ideas of the disease which it is intended to designate, for that which is commonly called caries is, strictly speaking, an ulcer in the bones; but ulcers of the bones are as different from the death of these parts as ulcers in soft parts are different from common mortification.

Diseased Actions of Bone.—Bones are very susceptible of diseased actions and dispositions, and sometimes a very slight accident will convert a disposition into an action, as in scrofula; and this may again be increased by the part of the bone which is injured; thus, in the case just related the effect is most considerable when it happens at the end of a bone forming part of a joint. The situation, with respect to the body, is also a cause of retardation in healing, as it is in the soft parts.

* [The reason of this is that these two layers are nourished by two different sets of vessels.]

Ulceration.—Ulcers of a bone are exactly the same in their immediate causes as those of a soft part, and in some of their effects also, the difference not being that of the disease but of the structure. Bones admit of every mode of absorption that the soft parts do. The most common cause of absorption in them is pressure; whatever makes an unnatural pressure gives a stimulus for the removal of the bone. Bones admit of being absorbed from debility, or want of power to support themselves; but this I believe only takes place in newly-formed bones.

Induration.—It does not appear that ossific inflammation takes place in the parts pressed, so as to make them firmer and harder, as in the soft parts. If bones were rendered harder they would have less power, and therefore would be more liable to death. However, there is often a thickening or running up of the bone all round, as in old dislocations, so that a new joint will be formed. Diseased bones communicate their disease to contiguous parts; most commonly to the nearest, as the periosteum; when near to the joints, to the ligaments or cartilages.

General treatment of diseased Bones.—This I shall refer, as much as possible, to the treatment required in soft parts, which is very similar, though the slow action in bones renders it more tedious, and requires a somewhat different method of cure.

If an abscess is seated in the soft parts, and also in the bones, that in soft parts will readily be recognised, from the difference in its appearance and feel from any of the surrounding parts; and it will in general approach the skin very soon, which, however, will depend very much on the nature of the disease and of the soft parts. The abscess in the soft parts will generally make a passage for itself, without the necessity of an artificial opening. But this is not so in bone; if a spontaneous opening takes place, it is not sufficient for a cure; therefore the trephine is often necessary; or it may be necessary to destroy the living principle in the bone, and then the actual cautery will be necessary. To kill the soft parts the caustic is sufficient; but the actual cautery is required for bones.

Of accidents to Bones.—The effects of accidents which hurt a sound bone are never to be reckoned as disease while it retains the actions of restoration natural to the animal body.

Injuries done to bones are of two kinds: one, simple injury without exposure; the other, injury with exposure. One simple injury is a bruise; another simple injury is a loss of continuity, as in a simple fracture. The union of the bone in simple fracture is exactly similar to the healing of a wound in the soft parts by the first intention; but here adhesive inflammation is unnecessary, though it generally happens from the irritation, and then adhesive inflammation is substituted for union by the first intention.

Simple fractures.—A simple fracture is a solution of continuity, generally with laceration of the surrounding parts, attended often with splinters of bone attached to the soft parts, or loose. The space between the broken surfaces of the bone and other parts are

first filled with extravasated blood from the ruptured vessels. This blood coagulates, and in time becomes vascular, as in the same mode of union in soft parts, forming a callus.* Then the arteries and absorbents, by their action, model the part, and form it into a cellular substance, in which the arteries deposit calcareous earth. It is first formed into cartilage, and then into bone. Adhesion of the detached splinters also takes place, interstitial absorption making them softer, and less pointed; and this takes place not only in those which are attached to the soft parts, but even in such as are entirely loose. (This was shown in a thigh-bone, in which one of the splinters had been turned quite round on its axis, and adhered by its outer surface to the bone.) Therefore these pieces must retain the living principle, and probably only this, while those that remain attached have more. I never examined a compound fracture without finding some of these loose pieces, which shows they must be common. Their union must be similar to that in the transplanting of teeth.

Callus.—The modelling of the callus to the parts in the neighbourhood is very evident in ribs that have been fractured, for on that side next the lungs the inequality is very inconsiderable. Whether the modelling in these cases is purely from the mechanical pressure of the lungs, or whether it is from absorption in consequence of that pressure, I cannot pretend to say: probably both

* [I have already observed, when speaking of the mode of union by adhesion in soft parts, that this is always accomplished by the effusion of coagulable lymph, which afterwards becomes vascular, and not by the organization of coagulated blood. The only difference in regard to bone consists in the time required for the ultimate organization of the new-formed structure. It is probable that there is no difference in the quality of the lymph (as it is first poured out,) from any of the structures of the living animal body, because the organic elements which enter into the composition of these structures are essentially the same, whether of bone or any other parts, viz. cellular membrane, nerves, blood-vessels, and absorbents. When a bone is fractured, the periosteum and surrounding cellular membrane concur with the broken surfaces and lining membrane of the bone to pour out a mass of lymph (*callus*), which gradually undergoes successive transformations of structure, until the new-formed part closely assimilates in all respects to the old structure. For the first week or ten days it is observed to consist of a soft vascular granular-looking mass, which gradually assumes, toward the twentieth day, a white and cartilaginous aspect, and at the same time diminishes in bulk: from this period to the fortieth or fiftieth day the diminution of the callus still proceeds, and the process of ossification is now observed to have converted the greater part of it into true bone, although towards the centre of the mass a portion may still remain, which is not fully converted into bone before the expiration of the fourth or sixth month. If at the end of this period the bone be examined, it will be found to be thick and irregular at the point of fracture; the medullary cavity will be found to be obliterated, and the new bone to possess the hardness of ivory. Ulterior changes, therefore, still go on for two or three years, which at last end in the complete restoration of the external form of the bone, as well as of the internal medullary cavity and reticulated structure. Dupuytren has called the external callus, which embraces the broken extremities of the bone like a bulky ferrule until the union is consolidated, the *cal provisionel*. There is not, however, as it appears to me, anything peculiar in this process to require the application of a new name, for the surrounding induration which attends the union of soft parts is precisely a similar phenomenon.]

may act. The increased solidity of the new substance is either from the deposit of new matter, mixed with the first, or from absorption of the first, and deposit of new matter instead. I think the last the most likely.

Ossification of the Callus.—The ossific substance is first deposited at the extremity of the bones themselves, and then extends to the callus; at the same time several points in the callus are forming ossific matter. Young people seem to have a greater disposition to form ossific matter than old, but there is a difference even in those of the same age. This new substance is similar to the original bone, and on this account probably is stronger than that from granulation; however, it is not so durable as the original bones are. This process must necessarily be more tedious than in the soft parts, in consequence of the second process which is required; sometimes no union takes place for a length of time after the accident, and the variety of callus is great.

Treatment in simple fractures.—Parts to be united by the first intention are first to be placed in their habitual position; but this cannot possibly be effected in all cases, nor is it always necessary in soft parts and when there is no external wound. In those parts which are for the support of the body, the fractured parts must if possible be brought into their original and natural position, before they are retained by bandage, &c.; but in some of these it is impossible, as in the ribs, clavicle, neck of the femur, &c., especially in fat lusty people. In such it is very difficult to say what the case is, or how the parts are situated. In the extremities there is more room for the exercise of art, but not in all equally.

Simple fractures seldom affect the constitution except the soft parts are much lacerated; then there is generally constitutional affection in proportion to the degree of inflammation. Rest of the part is necessary: in most cases, therefore, splints and bandages are used; and when there is much inflammation expected, a folded compress, moistened with some cooling lotion, is applied until the inflammation subsides, and then rollers and splints are applied, which should be tightened as the limb subsides. Spasms often arise from the splinters pricking the soft parts; I should think that a solution of opium would be the best application to remove this symptom. The position for the patient to lie in was formerly on the back; but the side is now generally adopted. However, I think its whole advantage is that it has the appearance of novelty, and is not a real improvement; but time will establish the truth. I prefer the back position, with the knee bent, as the patient will support this for the greatest length of time, and it is always the position of debility. In this position the limb will be kept more steady, and will be less liable to be moved by moving the body.*

* [The use of fracture-boxes, consisting of two inclined planes, the angle of which is regulated by a rack-work, has led to the almost universal adoption of the position on the back in fractures of the lower extremities. These boxes are of various construction, but most of them combine the double advantage, first, of

Period of Union, and manner in which this effect takes place.—The time in which the bone will be united will depend on circumstances. In the soft parts union will often take place in forty-eight hours: but it will require a much longer time in bones. In the first place they cannot be brought so closely into contact, therefore a larger quantity of new matter must become vascular; secondly, there is the second or ossific process to be effected; thirdly, there is laceration of the soft parts; fourthly, the state of the constitution and restorative powers may be weakened; fifthly, age. The situation too of the bone will cause a variation; the lower requiring a longer time than the upper extremities. In the middle-aged, and of a good constitution, union will take place in three weeks, so as not to admit of perceptible motion. If much longer in uniting, it will be very uncertain at what time this will take place: I have known it months, and yet unite at last. This slowness seems to be from imperfection in the two first bonds of union, the adhesive and the cartilaginous; sometimes from a want of disposition to ossification.*

These two, union by the first intention and that by adhesion, constitute the two first modes of union of bone; the third is where these two have failed, and here the union is effected by means of granulations from the broken ends of the bone and from the soft parts, which granulations become converted into bone (see *note*, p. 203). It is difficult to account for the failure of the first two: often it depends neither on the constitution nor the part; for the constitution has often been good, as is seen by it bringing on new inflammation on exposure.

I have seen a simple fracture where the two first processes,

an easy position, resulting from the semi-relaxed posture of the principal muscles, and, secondly, of admitting of the application of fresh bandages and dressings without being required to disturb the fractured member. Mr. Earle and Mr. Amesbury have contrived beds on the same principle, which effectually combine these advantages, and must be considered as most important acquisitions in the treatment of compound fractures.]

* [It may be observed that this want of disposition is particularly manifested during the periods of pregnancy and lactation, which would seem to divert the powers of the constitution from the reparation of the injury to the more important object of nourishing the offspring. The same effect will be produced by excessive depletion, or constant motion of the fractured extremities of the bones. By the former the naturally weak reproductive powers of bone are still further reduced, and by the latter the ossific process is arrested, and a new disposition created for the formation of a bursal structure, similar to what takes place in other parts of the body when friction is employed. It should be observed that constant motion of a fractured bone will inevitably lead to the formation of a false joint; but this will be differently formed in different cases. If the process of union has been interrupted from the commencement, the broken extremities will be found rounded off and covered with hard enamelled surfaces, inclosed by an adventitious synovial bursa; but if the interruption has taken place during the ossification of the callus, then the extremities of the bone will be united by a cellular or fibro-ligamentous structure. I am not aware that true cartilage is ever reproduced when removed from the surfaces of joints by ulceration, or ever found as a new formation on the extremities of bones forming a false joint.]

namely, the conversion of the blood into a vascular substance and the deposition of cartilage, had taken place, and the third had failed; and then, on allowing the parts a little motion, they got firmer, and at last perfectly strong.

False Joints.—Sometimes simple fractures will not unite at all. This is a worse consequence than any of the foregoing, there being no soft union even, or, if there ever was, that being absorbed. Here the surrounding parts thicken and form a kind of capsular ligament, and the extremities of the bone rub against each other at each motion of the limb, by which stimulus the broken parts are absorbed, and the extremities become smooth, and in time are covered with something similar to cartilage, and at length the cavity between them becomes filled with a fluid very much resembling synovia. In this case it is necessary to lay open the new cavity and irritate the ends of the bones, and then, by keeping them in position, bony union will often take place. It has been recommended to saw off the ends of the bones; but all that seems necessary is to irritate them sufficiently to excite a fresh inflammation.*

Inflammation of Bones.—Bones are subject to the adhesive, suppurative, and ulcerative inflammation, as the soft parts are.

The adhesive inflammation of bones is attended with this peculiar circumstance, namely, the formation of new bony matter in the inflamed parts, and therefore may be called ossific inflammation. Soft bones and the soft parts of hard bones are the most liable to inflammation and suppuration. Whether this arises from the structure of the bones or from some other cause, I cannot say.

The suppurative and ulcerative inflammation is the same in the bones as in soft parts, as is also the granulation and cicatrization.

When an injury is done to a bone sufficient to cause inflammation, or if inflammation arises spontaneously in a bone, then, some time after, there appears a swelling. This state is similar to the adhesive inflammation in soft parts. But pain appears to be the first symptom of inflammation in bones, and to precede the swelling a considerable time, whilst in soft parts they appear together. From this slowness in swelling it would appear to be a different operation, and it is

* [It has not been found that any plan uniformly succeeds. Among the least severe methods adopted in these cases may be mentioned blisters over the seat of fracture, or lateral or longitudinal pressure (according to the circumstances of the case) of the broken ends of the bone, so as to excite inflammation. Thus, Sir Everard Home procured a fractured femur to unite by encircling the limb with a stiff leathern belt, and making the patient walk. A seton passed between the ends of the bones has succeeded in a few cases; but the excision of the fractured extremities is much more effectual, although it is attended with the great inconvenience of shortening the limb. Mr. Hunter's is certainly a less severe method, and may be applicable to those cases, such as fractures of the tibia, where the bursal sac can easily be exposed; although I should mention that it has lately failed in two cases in St. George's Hospital. I believe, however, that time and a well-adjusted apparatus will succeed in the great majority of cases, without having recourse to any other method.]

difficult to understand how a bone can swell from extravasated lymph or calcareous matter, yet it is impossible to conceive that it is from any other causes. A swelled bone is true bone, and nearly as hard as any other bone;* it is easily distinguished from the sound bone and from swelling of the surrounding parts. A cylindrical bone seems most liable and ready to swell at its extremity or softest part, which is the last formed part; and this is agreeable to what I have before said, that the latest formed parts are weakest and least able to resist disease. But in the bones of the skull the swelling is generally in the centre.

Pain in inflammation of bones is more violent than in other parts. Whether this arises from the nerves being more compressed, or from the nature of the nerves themselves, is not easy to determine. This is rather a heavy depressing pain than an acute one, and is similar to that of rheumatism, generally more violent at night when warm in bed. This symptom is common to all inflammations of the bones and periosteum, though it has been supposed to be peculiar to venereal affections.

In this stage the constitution is not much affected, except from the long-continued pain, which may be so continued and violent that the patient may in the end become considerably affected by it. We cannot divide the bones, like the soft parts, into vital and non-vital; therefore we have not two species of symptoms. We have oftener, however, hectic from inflammation of the bones than from that of the soft parts.

The parts surrounding the bone generally, if not always, sympathize with the ossific inflammation; first producing simply adhesive inflammation of the periosteum, then of the muscles and cellular membrane. When considerable, this adds much to the swelling: the periosteum becomes fixed to the bone itself, so that this seems more swelled than in reality it is.

The soft parts contiguous to the bone, besides sympathizing with the inflammation, receive the ossific disposition. The cells which contain the marrow are subject to be affected, so that the cavity is filled up, and the bone increased in size. The ossific disposition takes place in the surrounding parts much oftener than either the swelling of the bone or the ossific disposition of the cavity; therefore it seems an easier operation to nature. This ossific disposition in the soft parts assists in the union of fractures and in the formation of ankylosis.

Here are bones [*exhibiting them*] where the ossific or adhesive inflammation had taken place in the substance of the bone, producing thickening of that substance; others where inflammation has taken place on the surface of the bone; and here, similar to the exudation of coagulable lymph on the soft parts, a coat of adventitious

* [There is great difference in this respect in different cases. Bones, in general, become spongy and light from inflammation; but there are other cases in which they acquire a hardness and denseness of structure little inferior to that of ivory.]

bony matter is laid on the surface of the bones by ossific inflammation. This in some, you may perceive, is laid on so close and so thin as to appear like ossification of the periosteum; in others it is loose and capable of being shelled off. In this bone of a lion it is laid on in places nearly half an inch thick, adhering closely to the bone; and in this it appears, from the little connexion it had with the bone, that the bony matter had grown from the surrounding soft parts.

From this preparation of one of the bones of the lion, which had been injected and steeped in acid, it appears that this newly-added bone was vascular, and had only lost its earth by this steeping, its form still remaining; it therefore must be as much an animal substance as the original bone. This appearance on the surface of bones, some years ago, before I gave these lectures, would have been supposed to have arisen from caries. If a bone is bent, broken, or hurt, &c., the consequent inflammation produces an addition of adventitious matter, which will strengthen the part even beyond what it originally was. In disease of the bone, when the ossific disposition does not exist, we may observe that the periosteum is very slightly attached to the bone, being as easily raised from it as the cuticle may from the skin.

Treatment.—The swelling of a bone, if of no specific nature, requires little chirurgical treatment, but will most probably require internal and external medicines before it can be reduced to its original size.

If a bone be only in a state of adhesive inflammation, every method is to be used that is used in inflammation of other parts, as bleeding, rest, &c.; and if in the lower extremities, a horizontal position will add greatly to the cure. Fomentations will give ease, especially when near the skin. However, this treatment is sometimes ineffectual, and suppuration comes on.

Suppuration, however, is not always the consequence; for in some cases the bone becomes indolent, and remains swelled for years. I believe bones are more likely to take on the indolent habit than other parts. The adventitious bone may always be considered as in a weak state, not being an originally-formed part, and as it is often in parts where it becomes an incumbrance, must be considered as a disease; and if it could be removed it would be of service; but in most cases this could not be done without producing worse effects.

When bones take on this indolent habit, it will be necessary to rouse the diseased part to action. For this purpose mercury may be used internally, and pursued for a considerable time in a middle dose between what would be used in a venereal affection and what would be given as an alterative.

Mezereon has been much recommended in indolent swellings. The decoction recommended by Dr. Russell is to be made as follows. Fresh mezereon root one ounce, pure water a gallon and a half. Boil it in a copper vessel tinned, over a moderate fire down

to a gallon. Towards the end of the boiling, add an ounce of liquorice-root, sliced. Half a pint is to be taken three times a day, which is more than most can drink. This does not increase any of the secretions, except being a laxative in a very few cases. It has been tried with double the quantity of mezereon, but was then too pungent for the stomach. Patients using this decoction are not confined to any regimen. The medicine has been strongly recommended in the Medical Observations by Dr. Russell. The cases he has described I should not call venereal, though they were treated as such, but scrofulous; therefore we may find mezereon a good remedy in scrofula. It cannot be considered as a specific in syphilis, as it is only useful when the bones are affected.

Of the Suppurative Inflammation in Bones.—When the ossific inflammation is not cured, suppuration takes place. There is no visible difference between suppuration in bones and in the soft parts; for as bones are composed of animal matter with calcareous earth, there is no reason why they should not go through the same process. Suppuration does not indeed take place so readily in bones, the inflammation often not reaching so far. Whether this proceeds from an indolent disposition stamped on them from the first, or from their structure, I do not know; but whenever suppuration takes place in them it is a serious piece of business. The periosteum and surrounding parts are more ready to take on suppuration than the bone itself, yet it may originate in the substance of the bone. The consequence of suppuration is ulceration, which may also originate from pressure, or blood lying on the bone. There is, I believe, no difference between the ulceration of soft parts and of bone, the adhesive going on with the suppurative in the soft parts; so in the bone we have the ossific going on with the suppurative. To repair the loss that has been made, Nature sets herself to work to repair the loss with granulations. The intention of these is, to fill up abscesses; to repair compound fractures; to restore the part lost by trepanning, &c. Nature sets about to repair these injuries of bones by the same original principles by which bone was first formed: thus, if a cylindrical bone is to be restored which was originally formed on cartilage, the first step to its reproduction will be the formation of cartilage; if a bone in the skull, it will be of membrane. But we sometimes have too great a disposition to ossification in the granulations, so as to make the new part bulky and inconvenient. A difference is observable in the newly-formed substance which arises from ossific inflammation and that which is formed from granulations in consequence of ulceration. The former has a smooth fibrous appearance, very different from the latter, the surface of which is granulated, as if the bone had grown from the centre to the circumference, the grain being of a sandy texture.

Compound Fractures.—These differ from simple fractures in the first and second modes of union being lost; and therefore the third, by granulation, takes place. The granulations between the ends of

the bone and on the lacerated surfaces take on an ossific disposition, and the suppuration is always more or less surrounded by the adhesive inflammation, so that it extends pretty far, and consequently the callus is large. Hence these fractures are so tedious and dangerous, especially when in the lower extremity, which is their usual situation. There are no bounds to the mischief done by a compound fracture: the loss of the uniting substance by the wound, and the loss of the living principle to what remains by the exposure, are causes of the failure of the first process; and, besides, the ends of the bones are sometimes so locked together as to require to be sawed off, or so denuded of their investing membrane as to lose their living principle and to exfoliate, as the dead part must be thrown off before the wound can heal. This sometimes takes six or eight months, and is so extensive as to be very dangerous. The inflammation, too, which follows the accident is commonly very considerable, and may proceed to mortification.

Treatment.—The only peculiarity in compound fracture by which it differs from other lacerated wounds is the breach of continuity of the bone, which admits of motion in the part where none was intended. This singularity it is which requires a peculiarity in the treatment, as this motion and the operations of nature are in contradiction to each other. A variety of inventions have been employed to prevent this motion; but the dressing of the wound every day counteracts the effect of every invention that has been thought of, and it is perhaps impossible to dress the sore without motion (see *note*, p. 271). At first the part is generally put into a poultice, but changing this must give considerable movement. Instead of a poultice, I would lay the leg or arm in cloths, doubled several times, and wetted with goulard, and lap them over so as to come into contact. These should be wetted occasionally, and continued until the inflammation is over and the suppuration takes place. When the wound is on the back of the leg we shall be obliged to raise the leg every day to apply the cloths. A bit of oil-cloth should be put under the leg, and wiped clean every day.

The time of union of a compound fracture is necessarily much longer than that of a simple fracture, from the processes they have to go through, and is very uncertain; but the union of the bones is generally effected long before the external wound is healed up, for whatever retards the cure of the bone retards also the cure of the sore. When granulations have been formed and bony union is late in taking place, and the wound is healed up or nearly so, it should be treated like a simple fracture in the same circumstances, and gentle pressure is of use, as walking, with a machine to take off the weight of the body: here necessity acts as a stimulus for bony union to form.

Compound fractures do not always take on the bony union: but there is never a want of soft union, as there is at times in simple fractures; and therefore new joints are never formed, as they are

sometimes when simple fractures do not unite by the first or second modes of union.

Compound Fractures communicating with Joints.—Joints do not so readily go through the suppurative and granulating inflammation when wounded as other parts; and it would be improper for them to do so, as it would produce ankylosis. If, in a compound fracture, the fracture extends to a joint, the question arises, What shall we do? The injury may be viewed in one of three lights: first, as a compound fracture; secondly, as a laceration of a joint: thirdly, as a compound of both. If it is such a fracture as seems impossible to recover, it is not necessary to consider the joint at all, but amputation must be performed. If the laceration into the joint be such that, although the fracture may not be considerable, inflammation and suppuration of the whole joint must come on, then it is probable that amputation must also be its fate. But if the fracture appears to be such as may unite, and the laceration in the joint be such as can unite by the first intention; if the fracture be such a one as we think would do well when restored to its situation, if not complicated with a wound in the joint, it becomes dubious what ought to be done. If the wound in the joint will admit of being kept from exposure, then we may consider the case as one of compound fracture only. This sort of injury most often happens at the ankle joint, this tibia being very liable to fracture at its lower extremity. All wounds of the joints should be healed by the first intention, if possible.*

Of Fracture of the Patella, Olecranon, and outer Ankle.—The peculiarity attending these fractures is, that they make the lateral part of a joint so exposed that the fracture communicates with the cavity of the joint which gives an exit to the immediate bond of union. The treatment of the patella and the olecranon will be very similar, because they not only make the lateral parts of joints, but they have inserted into them the tendons of considerable muscles. Hence the fractured ends are separated from each other, instead of riding over one another as in common fracture, and a different treatment is consequently necessary.

As the fractured patella is commonly produced by a contraction of its muscles, especially when opposed by a resistance of other

* [The question of amputation in cases of compound fractures, is one which depends on many circumstances: as, for example, the implication of the great joints; the degree in which the soft parts are bruised and injured and the bone comminuted; the injury of the principal vessels or nerves of the fractured limb, as well as the age, previous habits, and present conveniences of the patient. Without, however, going into the subject further, it may be sufficient to mention that surgeons are now more in the habit of trusting to the efforts of Nature than used formerly to be the case; so that cases which would certainly have been condemned by Pott and Hunter are frequently saved in the present day. Where youth and a sound constitution exist, the surgeon should be especially careful not hastily to condemn a fractured limb because the joint happens to be implicated, or on account of any other simple circumstance; but should reflect how extensive the resources of Nature are, and that an attempt to save the limb in the first instance will not necessarily preclude his having recourse to the remedy of amputation in a later period of the case.]

muscles, the fracture is then transverse, and then the muscles are at liberty to contract to their full extent, and consequently the broken part of the bone above is drawn up the thigh with them, for the rectus muscle has more than a simple power of extending the leg, namely that of bending the thigh on the pelvis.

Treatment.—When the ends of the fractured bones are pretty soon brought tolerably close together, I can conceive that union may take place as in simple fracture. Before the year 1750 it was the practice to endeavour to bring the broken ends of the bones as near together as possible, with little or no motion allowed; but after that a fashion arose (for we have fashions in surgery as in everything else, arising perhaps from a person happening to do well who had not been treated in the old way,) of letting the parts separate, and of not forbidding motion so strictly; but now caprice has I believe had its day, and we are taught by reason and experience that the parts should be, when cured, as nearly as possible in their natural situation. To effect this, the upper portion of the patella should be brought down as much as we can, and the common bandage be applied. It may be imagined that in the treatment it is not only necessary to extend the leg, but to lay the thigh at right angles with the body; but from a complete knowledge of all the circumstances, it will appear that this practice is not at all necessary; for as the rectus has a greater power of contraction than extending the leg, so it must also be granted that it has a greater power of relaxation; therefore it is not necessary to place the leg at right angles with the body.

Fracture of the patella seems to be cured by Nature, in the manner of the simple fracture, by granulation, because the first and second bonds of union have escaped into the cavity of the joint and have been absorbed. But, perhaps, if the ends were brought together earlier, they might be united by the same means as the common simple fracture, especially as we sometimes see a luxuriance round their edges, which is probably owing to the ossific disposition having taken place in the coagulum. But if the first and second modes fail, I conceive the third, by granulation takes place: the ends of the bone and ligaments exuding coagulating lymph, which coagulates immediately, and, taking vessels as in other granulations, becomes not bone, but a kind of tendinous or ligamentous substance; which seems a wise provision of Nature, because if they were united by bone, this might be of such a length as would prevent the motion of the joint, except with the leg at right angles with the femur.

When union is formed it would be proper to give some passive motion; but voluntary motion is always better, because the will is always sensible how far the powers of a part extend, and will attempt no more; but if force is used to extend a part, all the muscles of which have not their due power, it may be thrown into such a situation as to give an improper action to a weak muscle: the will alone is proper to perform those actions she has determined on herself.

The method of cure by ligament only is very tedious; but there are other things to be done after this union has taken place. First, the accommodation of the muscles to their new situation, where less length is necessary, from the patella having become longer; secondly, the new contraction in this new situation; thirdly, acquiring sufficient strength in it.

We have reason to believe that the greatest contraction in a muscle is somewhat greater than the joint will allow of; for we find them firm when the limb is stretched as if the power was greater; and when the part is deprived of this firm band we find the muscles draw the bone up higher than they should. Thus the upper part of the patella is always drawn up when the bone is broken. While the union is taking place, the muscles are accommodating themselves to the great length of the bones. After this it will be necessary to bend the limb and keep it so, in order that the muscles may be thus enabled to admit of an elongation equal to the flexure of the limb, by which means the patient will be enabled easily to bend the limb. Extension will not be so easy; but still by perseverance it may be acquired, as the following case will show.

I called with a friend to pass a day or two with a family in the country. The lady of the house had had her knee fractured, and had been treated according to the maxims the surgeon had learned while attending the London hospitals, which at that time were to leave the whole unconfined, and take no measures to bring the portions of bone together. She recovered from the accident, but was totally unable to use the limb, and had to be wheeled about in a chair. Her leg was made to swing backwards and forwards as she sat on a high table or chair, but still she had no power of contracting the rectus muscle, and as soon as the force that gave the motion ceased, the motion ceased with it. It was not until several years after the accident that I saw her; and, having spent a whole night in considering the probable cause of her loss of power, it appeared to me that the space between the two attachments of the rectus being much shortened, while the muscle continued of the same length, the utmost degree of its contraction would scarcely be able to straighten itself, much less move the patella and leg also. I advised her to sit as before, but instead of having her leg moved, to move it herself. This she could not in the least effect at first. I considered, however, that the power of contraction which the muscles possess beyond that necessary for the mere purpose of extending and flexing the limb, as mentioned above, is probably obtained by the mind's influence on the muscle; and that, in this case, if the influence of the mind was frequently exerted on the muscle, it would gain this power of contraction, in which it would probably be aided by the interstitial absorption taking place, and actually shortening the muscle and suiting its length to the office it was to perform. I therefore advised her ladyship to repeat her exercise, as often as she could, every day for a month, assuring her that if at the end of the month she had obtained the least power of motion, I had not a doubt that she would

again be enabled to walk by a regular exercise of the muscle. The event proved as fortunate as I could wish: the lady, at the end of three or four months, being able to walk, although she had not walked for years.

Fracture of the Olecranon.—The olecranon may be considered as a fixed patella, the inserting-point of a considerable muscle, and when broken is drawn up as the patella. The immediate treatment is the same; but the consequences are often different, as it should always be united by bony union. The arm should be extended, and kept so; and the upper portion brought down, if up, and retained by a bandage, which will be somewhat similar to those used after bleeding. When soft union has taken place, and bony is beginning, passive motion of the joint should be made. As the union gets stronger, the motion should be increased, but should not be very great till bony union is completed, as before this it will bend the olecranon over the lower end of the os humeri, and occasion it to make a smaller curve than it should do, even an angle; by which the full extension will be prevented. This, by proper attention, may be avoided.

Fracture of the Ankle Bones.—It is possible for these to unite in general, like simple fractures, as the displacement can hardly be very considerable, unless great injury has been done, here being no muscle fixed to them, the contraction of which would draw up the parts; so that the extravasated blood and juices may be sufficient to unite them by the first intention.

Suppuration in Bones.—I shall first consider that on the surface of bones, or on the periosteum; secondly, in the substance; thirdly, in the medullary parts; fourthly, may be reckoned that in the joints, which is similar to that of a bone; but, as it is attended with consequences peculiar to the nature of the part, I shall treat of them after.

When inflammation attacks the surface of a bone, the first effects are adhesive; and when suppuration takes place, the periosteum is separated as far as the suppuration extends, making underneath a cavity for the matter. As the adhesive state takes place some way round the abscess, there is in many cases a circle of adventitious bone formed in the periosteum round the abscess. This will be more or less, according to the rapidity of the suppuration: if it takes place soon, there will not be time for the ossific inflammation; if slowly, a ridge will be formed, as is often the case in the cranium giving the appearance of bone being wanting under the muscles. As soon as ever it is known that suppuration has taken place, it should be freely opened, to prevent as much as possible the separation of periosteum;* granulations will form, and in proportion to

* [The propriety of this direction cannot be questioned as regards those cases where collections of matter between the periosteum and bone give considerable pain, or where, suppuration not yet having taken place, the suffering from the periosteal inflammation cannot be subdued by the ordinary antiphlogistic and mercurial treatment. It should be recollected, however, that considerable col-

them will the ossific disposition follow, which ossific disposition is often not confined to the granulations, but exists in the surrounding cellular membrane, &c.; so that, around the bone, ossific matter is deposited which increases it very much in thickness: this is seldom the case when the granulations are healthy, but almost always when unhealthy. The oftener bones have undergone inflammation and ulceration the thicker they become, and also much more subject to it, as we evidently see in working-people's legs, &c. Often, from the separation of the periosteum, part of the bone dies, and must exfoliate.

The second Species.—This is of greater consequence, as more of the bone becomes diseased. When inflammation attacks the substance of the bone, it is seldom that the whole diameter of the bone swells, generally only on one side, where the suppuration is. This must at first be much confined, from the solid parts around, and ulcerative inflammation is obliged to take place early; and accordingly, as in common abscesses, the ulceration goes on towards the soft parts, and until it arrives there it is impossible to tell whether there is abscess in the bone or not.* It will burst, as usual in abscesses; but this probably does not so quickly take place here as in soft parts. When near the external surface, and so near the periosteum as to give it the stimulus of adhesion, then the adventitious substance is formed on the external part of the bone, while its substance is gradually lessening internally by absorption; but the addition externally is not in proportion to the internal loss, and therefore it bursts externally. [*Preparations of this were shown where suppuration and ulceration had taken place in cylindrical bones, as in the tibia, &c.*] This used to be called spina ventosa.

The third Species.—Inflammation in the medullary part is still more serious in its consequence than the last. The body of the bone thickens from the adhesive disposition, and also the ossific disposition takes place in some degree in the periosteum all round, so that the external parts are much increased in bulk; this only takes place in the bones of the extremities, where strength is necessary, and never in the scalp, &c. The ossific disposition in the medullary parts takes place at all points of the abscess; and by this the other part of the marrow is saved. When suppuration takes place, there being no vent obliges the ulcerative inflammation to take place: on all sides and on the outside additional matter is deposited. Nature intending to keep up the strength which it is losing internally; the

lections of pus, arising from a venereal cause, are frequently dispersed by an appropriate treatment directed to the cure of the original disease; especially when such collections are situated on the frontal bone.]

* [Notwithstanding the great obscurity which involves the early existence of these cases, yet it is not always impossible to discover their true nature. In the clinical lectures delivered by Sir Benjamin Brodie, that gentleman has related several cases in which he has detected and given exit to circumscribed abscesses in the heads of bones entering into the composition of the large joints. Such cases are marked by a fixed deep-seated pain in some determinate spot, unattended by any considerable swelling of the parts, or disease of the neighbouring joints.]

newly-formed bone is itself disposed to the ossific inflammation, by which it in many parts becomes much thickened, so that the remaining shell is often entirely new. Where the two opposite processes do not bear a proportion to each, the bone becomes often so very thick as to resemble a compound fracture. In the two last mentioned we have often exfoliations, as well as in the first; they are less favourable, from their situation being different, and are called internal exfoliations. The head of the tibia is more subject to abscess than any bone in the body. The medullary arteries and membrane, which furnish nourishment for the internal laminæ of the bones and marrow, is the seat of the inflammation producing it. [*A preparation was shown where it was very large, but only a mere shell remaining.*]

Treatment.—When the adhesive or ossific inflammation does not stop, but goes on to suppuration, it must be treated as inflammation in soft parts. When the suppuration is superficial, so that the bone only makes one of the sides of the abscess, the matter will come immediately to the surface.

All the soft parts are to be laid freely open, or entirely removed. This is necessary *in all* wounds, where healing does not take place from the bottom, to expose them and bring on inflammation; and when there is exfoliation, the opening is more necessary, as it cannot heal until this is removed, and it will sooner be removed and healed by exposure. It will often be necessary to remove a part; but when the skin and bone are very near, then it must be only a simple opening, without removing the skin, as in such cases the skin is fixed very much to the bone, and should not be lost; and again, here the granulations have less power to contract than in deeper and more fleshy parts, and there is less danger of sinuses or fistulous openings; but when deep-seated, simple and free openings are insufficient, and some parts must be removed, otherwise the external opening will close, and fistulous openings will remain till the bone has recovered. Bones are very apt to fall into an indolent inactive state, which should be discovered, and stimulating dressings applied. Oily dressings have been objected to; but oil has neither a power of promoting nor retarding granulations, though the former has been imagined to be the case. By this means they are often cured, but are afterwards very liable to new inflammation; and this is generally attended with ulceration, which begins in the skin. This is owing to weakness in the part, and is most frequent in the lower extremities.

In some cases it will be necessary to apply the actual or potential cautery to the bone.

The treatment of these cases is various, and the cure is generally very difficult. They are seldom understood: at first they may appear as a common abscess, and are often opened and dressed as such, which, proving generally ineffectual, leads the surgeon to a more particular examination, and he easily discovers a diseased bone, if the opening has been free. As the bone cannot be dilated by a cutting instrument, it must be killed either by the potential or

actual cautery, or sometimes the trepan will be useful. After exfoliation is finished, the same dressing as in caries is required; but in many cases it will be necessary to do something more. The cavity of the abscess in some requires to be exposed, by removing surrounding parts, as is sometimes done in abscesses of the soft parts before they will heal.

Of the Matter in Diseased Bone.—The matter discharged from a sore where there is diseased bone is seldom good matter, especially if it become fistulous. The diseased bone that is bare is often producing mechanical effects, such as rubbing the soft granulations, so that there is a small quantity of blood mixed with the matter, which gives it a bad colour. Such matter generally blackens or in part corrodes silver probes. This probably arises from the hepatic air (sulphuretted hydrogen gas) which Mr. Kirwan has discovered to be produced by the putrefaction of animal matter.

Of the Shortening of Muscles of Diseased Joints.—Joints when diseased naturally get into a middle state between flexion and extension; and, as the joints are passive, this must be performed by the muscles, and either by their voluntary or involuntary action. This stiffness of the joint depends on the involuntary contraction of the muscles, and is in consequence of the muscles sympathizing with the joint. But this involuntary contraction is not like tetanus; the muscles in this state feel like strong cords, and, if straightening the joint be attempted it seems to the patient as if these cords were breaking. As the joint loses its power of motion by the disease, in that proportion the muscles are altered; they adapting themselves to the quantity of motion the joint will admit.

In the artificial extension of a joint which has been contracted, the muscles which are contracted should never be called into action, because the parts which ought to lengthen will thus be shortened. To illustrate this, let us suppose the gastrocnemius and soleus muscles to be contracted, and to draw up the heel, so that the patient rests on his toes, his foot being in a line with his leg: in walking he will involuntarily use these muscles to give firmness to his leg. In this case we should give support to the heel in a degree. By this means the patient, convinced of his ability to bring his heel as low as the support requires, will cease voluntarily to contract the gastrocnemius and soleus muscles, and they by degrees will acquire the property of relaxing themselves; which, if the heel was entirely supported at first, they would have no occasion for, and while altogether unsupported they never could.

OF SPRAINS.—In sprains the ligaments are probably often torn; for in most sprains there is a considerable extravasation in the surrounding cellular membrane.

Considerable pain is felt, at the time of the accident, of the heavy dull kind, which often produces sickness, and the blood leaves the skin of the body generally. Considerable swelling takes place, and this is almost instantaneous. The swelling arises from two causes; the surrounding cellular membrane being loaded, and the increased

secretion of synovia into the joint. This will be more visible in the joints where the capsular ligament is loose, as in the joint of the knee above the patella.

These symptoms are succeeded by inflammation, which produces great pain and sensibility on motion. These parts are very insensible in a sound state, but they easily move from a state of insensibility to one of sensibility. Nature does not seem to have bestowed so much pains on these parts as on others, for they have very weak powers of restoration, which produces tediousness of cure.

Treatment.—In the first place, rest should be employed, with topical bleeding. Pumping on, or long immersion in cold water, and friction with vinegar, lees of wine, spirits of wine, &c. on the part have been recommended. Whether these last remedies serve any useful purpose or not I am undetermined: but we know that sprains are at least seldom perfectly cured. I have known the effects of a strain continue through life (above fifty years), always swelling and becoming painful on the least violence. Where there is a perfect cure obtained, I suspect the ligaments only have been injured, and not the cartilage, which is extremely slow to restoration. Though the mechanical strength is recovered, yet a weakness is often found to remain, which may sometimes be removed by some application which has not been before applied, as a pitch-plaster, opodeldoc, &c., which gets the credit and the name of a specific: but these often fail. The same applications are often recommended in the second stage as in the first, but to use it in the same way must be improper. In the second stage cold water should be applied no longer than to excite heat. Sprains often remain very painful after the original symptoms have been removed; this pain is often removed by giving the part motion, as if some part was moved into its place by that motion; but it is most probably by the motion's giving the parts an opportunity of adapting themselves to each other's action.

On Dislocation.—This term generally is applied to bones, and probably might also be applied to cartilages, when any two bones forming a joint are displaced. Probably the articulating substance or ligament is torn; but this circumstance is not yet well ascertained. In many joints a lateral motion must be applied to produce it, the muscles being at right angles with the bone that they move, &c. When the head of the bone has moved beyond a certain point, then the antagonist muscle is unable to bring it back, and then it requires some passive motion to bring the bone so far back that the antagonist muscle can replace it. A lady had the tibia brought too much below the os femoris, by too great flexion: the surgeon attempted to replace it, by bringing the foot forward, and so to replace it by the extensor muscles: but I thought the tibia was got beyond the centre of motion; therefore I conceived that the above means would make it worse: he then, by my direction, raised the head of the tibia a little upwards, by placing the hand

in the ham, and the reduction of it was then finished by the extensor muscles.

General observations on the Reduction of Dislocations.—As joints are composed of two parts, one more moveable and the other more fixed, the more fixed might be called the reactor, and the moveable part the actor. When a violence has been applied to the actor there is a deformity occasioned, as if this was out of its place, yet both are equally so. In dislocations the powers are generally applied to the actor, and though in most cases the reactor does its office spontaneously yet it often requires assistance. In most joints of the body the reactor can be made more fixed, as, *e. g.*, the body in dislocated hip, but in the shoulder there wants a counter resistance, or reactor, the scapula being so very moveable, and hardly to be fixed by art: hence extension is obliged to be more on the muscles, as the latissimus dorsi, pectoralis, &c., than on the ligament where it should be; therefore, to reduce it, it is necessary to make the scapula a fixed point, to do which often requires much labour and some art. When you stretch the shoulder as far as it can, the scapula is brought forwards as much as possible, but the latissimus dorsi and pectoralis major prevent the os humeri from being extended on the scapula beyond a certain point, which is much against you in the reduction.

In reducing a dislocation the bone should be returned exactly in a retrograde motion, overcoming that effect first which was produced last, and then a lateral motion is to be made in a contrary direction to that motion which occasioned the dislocation; in doing this the most immoveable part is to be the fixed point if possible, and the moveable is that which is to be extended. This is to be done as soon as possible after the dislocation, as afterwards the parts will become adapted to their new situations, and render the reduction more difficult, and sometimes impracticable.

New Joints produced in consequence of Dislocations.—We have sometimes new joints produced in consequence of dislocations when the bones are not reduced, which brings the parts into somewhat of the condition of simple fracture; and there is the same disposition between the two surfaces in contact as in simple fractures which do not unite by the soft continuity of parts. But this can only be when the dislocated bone comes in contact with another bone, as the thigh-bone with the ilium. When the two bones rub and press on one another absorption of the external surface takes place, the adhesive ossific inflammation goes on around the edges, a fluid is secreted in the cavity, and thus we have the new joint. These joints of necessity oftenest take place in the thigh-bone than elsewhere, but sometimes between the os humeri and the scapula.

The effects of Accidents and Inflammation of Joints.—They being circumscribed cavities, are subject to the same diseases as other circumscribed cavities, as inflammation, &c., but their peculiar structure sometimes renders their consequences different. Nature is very little disposed to take on the adhesive inflammation, because

the necessary consequence would be loss of motion in a part originally intended for motion. This makes inflammation in joints so much worse than in any other circumscribed cavities, for, as before observed, if adhesive inflammation does not come on, the inflammation and consequent suppuration must spread through the whole cavity.

The joints are mechanically strong; yet this is not that sort of power which resists disease; but they have sometimes a greater disposition than other parts to disease; and sometimes they become diseased from the violence of accidents. They are slower of cure from their composition, than other circumscribed cavities are; besides, they are also subject to specific diseases, from the materials which they are composed of, and more backward in their cure. Inflammation in joints is generally of more serious consequence than in other parts; even when resolved it is disagreeable; yet this is always to be wished for. Inflammation from accidents often does well without any adhesion, but not when it arises from other causes. In all inflammations of joints there is a swelling, from extravasation, into the cellular membrane and cavities, as in the knee above the patella, where there is a *sacculus mucosus*. In inflammation from accidents the treatment must be similar to that in other parts, but here suppuration is particularly to be prevented if possible. Rest, topical bleeding by leeches and cupping, fomentations, blisters, purgatives, &c., are here to be particularly employed; but as joints are very apt to become scrofulous, the patient should go to the sea when the swelling becomes chronic and appears to be at all stationary. Another cause of accidents here, besides strains, is extravasation of blood.

Of loose Substances found in Joints.—These are ligamentous, cartilaginous or bony. Though there are often extravasations into joints, yet they seldom produce adhesions, although sometimes there are appearances as if blood extravasated into a cavity of a joint had become vascular. To explain this we must have recourse to the living principle of the blood. This, I suppose, when it is extravasated into a cavity, adheres to the cavity, and is not absorbed nor loses its living principle, but becomes vascular, and afterwards membranous, cartilaginous, or bony, according to circumstances. Its attachment being rendered small by motion, it becomes easily broken off. The treatment of these cases we have before mentioned when the joint was sound; sometimes there is more than one of these substances. I know a gentleman who has four; therefore if an operation was to be performed we must take care to manage it so as to extract all of them at once.

They may often occasion lameness in other joints where they are not discoverable; but they are most liable to form in the knee-joint, from its greater size, and other joints might not so readily show their existence. These loose bodies can only be removed by making an opening into the joint, and this should only be done when they are evident. On the inside of the upper end of the

patella is the best place; the loose pieces should be squeezed to that part, and then carefully surrounded by three or four fingers of an assistant: the incision should be longitudinal and in length proportionate to the size of the loose bodies. The wound should be closed immediately by adhesive plaster and the uniting circular bandage, and the patient kept in bed for some days to procure the first mode of union if possible, the leg being kept quiet and extended, and the occurrence of inflammation carefully watched.

Anchylosis.—This is an union of bone with bone which ought not to be united, and is of two kinds,—one by soft parts, the other by bone. In inflammations of joints we often have adhesions by a soft medium. Very considerable inflammation is necessary to produce anchylosis in joints, and much time is necessary for their perfection, as we see in white swellings. The adhesions are sometimes partial, sometimes universal. The soft is from two modes, viz. adhesion and granulation. The soft only can take place when there is naturally no intermediate substance, and the joint is surrounded by capsular ligament.

Bony Anchylosis.—I shall divide bony anchylosis into five kinds, four of which are in the surrounding parts, by ossific inflammation, the other by an entirely new substance, betwixt the extremities of a bone. Distinct and separate bones are naturally united, either mediately or immediately; that between rib and rib, between tibia and fibula, and radius and ulna, is lateral attachment. The second is when there is an appendage for the union of two bones, as in joints in general; this is of two kinds, viz. 1st, when the whole surface is united by soft parts, or ligament, as vertebræ to vertebræ; the other, when only round the extremities by capsular ligament. These will have different effects. When there is no continuity of soft substance, but only the bones, then the inflammation is obliged to shift the ligaments for bone.

Of the first, from lateral attachment where there is no joint.—This generally takes place only when the bones are so near as to partake of the ossific inflammation between them, as in the tibia and fibula. This anchylosis is of little inconvenience, except between the ulna and radius, when their motions will be rendered imperfect. [*A preparation was exhibited which showed the union of a tibia and fibula, by the ossification of the interosseous ligament; another, the union between two ribs; and another, the union between two of the metatarsal bones.*]

The second, or in surrounding parts.—This often takes place in bones united by their whole surface, as between vertebræ and vertebræ, and I have seen it between sacrum and ilium; it often occurs in the human species, but much oftener in horses. The ossific inflammation would appear in such to arise from the bone, as it is found to be in different degrees. Sometimes the ossific inflammation attacks the periosteum around the connecting substance, leaving this as free from bone as ever. In a horse the vertebræ unite, not by ossification of the intermediate substance,

but by the periosteum covering them becoming ossified. The same also occasionally happens in the human vertebræ, the intermediate substance not being at all ossified.

Of the third, or between bone and bone.—Within joints, but with a continuity of substance, ankylosis often takes place in the vertebræ, by ossific inflammation having existed in the intermediate substance. These specimens [*exhibiting them*] show the intermediate substance ossified, while the external parts are little or not all affected. In the spine of a lion both are affected.

The fourth, by capsular ligament.—This is much worse than the former, here the bones having a considerable motion, and this motion very necessary; but in some of these joints there is more inconvenience from ankylosis than in others; it is from the capsular ligaments taking on the ossific disposition, after strains and other injuries; however, this is much less frequent than the others and very long in coming about throughout and all around the ligament, though a partial ankylosis may take place which will render the joint stiff. [*A preparation of the os ilium, ankylosed in part with the glenoid cavity, by the surrounding capsular ligament becoming in part bony, was shown. In the elbow another was shown, of this species of ankylosis.*]

The fifth, by the whole substance of the articulation.—This is of two kinds, and these kinds are the only ones which can admit of the soft ankylosis. It is somewhat similar to the union which takes place in soft parts; it arises from two causes, viz. 1st, from inflammation of the parts themselves; 2dly, from the inflammation of the surrounding parts, the parts themselves partaking of it. Sometimes the cartilages are ossified, and a new substance is formed on them, which I rather think arises from granulations without suppuration. Joints have lost their motion from inflammation in surrounding parts. A lady had an inflammation come on from the opening of a sacculus mucosus on her elbow, which inflammation was very violent, and extended to the joint, soon after which she lay in, and died of puerperal fever. On opening the joint, soft union was found to have taken place, which, if she had lived, would probably have become bony, and the joint would have been ankylosed, merely from adhesive inflammation.

Of Suppuration in Joints producing Ankylosis.—This is of two kinds, viz. truly inflammatory and scrofulous; the former we shall now treat of principally. If the inflammation is carried on, an abscess is formed in the cavity, as in any other part; and the suppuration is more universal in the cavity than in other parts, being diffused through the whole. This continues to approach nearer and nearer the external surface, and either breaks or may be opened: so far as they are connected with bone they are similar to compound fractures; but the suppuration is slow, and takes place with difficulty, and then generally falls into the natural scrofulous disposition, which renders it tedious. The suppuration is then imperfect, appearing to partake of both the adhesive and

suppurative. The ulcerative disposition is slow in bringing the matter to the skin, which arises from the indolence of the prior suppurative disposition and inflammation. The ulcerative inflammation sometimes goes on, so as entirely to alter the joint, that is, the receiving cavity becomes larger, and the received part less; this is often the case in the hip joint. These cases then become very tedious, and generally very uncertain in their cure. Before they are opened they are generally become so indolent that opening has very little effect; and often when scrofulous such a disagreeable inflammation comes on as to destroy the patient, and therefore amputation had better be performed at once if this disagreeable inflammation does not take place immediately after opening; yet a fistulous opening is generally the consequence.

Soft Anchylosis from Granulations.—A joint so healed has no cavity left, the surfaces uniting. A joint coming to suppuration from not being resolved in the first mode, but forming granulations, is more tedious than in the soft parts. The granulations cannot contract here, as they do in the soft parts, and the powers of restoration in them are very weak.

Bony anchylosis takes place when the granulations ossify, so that the two bones are united into one exactly similar to a compound fracture. [*Preparations were shown; one, of the thigh united to the acetabulum; another, of the ulna to the os humeri; and another, of the metatarsal bones.*] But when the suppuration is healthy the joints sometimes recover: in such cases the matter is sooner discharged, and the parts are more disposed to return into their original state.

The modes of cure.—The first attempt should be to resolve the suppuration without opening. In some the cartilages have been destroyed (which may be known by the bones rubbing against each other,) and replaced. This I have seen in the knee. When a healthy process is going on, the joint should be attended to. Rest should be prescribed, both before and after it has taken place; when it is recovered pretty well, a little motion, and gently repeated, should be allowed; thus a cartilage will gradually form on the parts moved.

The second mode of cure is the formation of granulations, which makes anchylosis complete by their union.

Of Muscles losing their Action from injuries done to Joints, Tendons, and Ligaments.—It is remarkable that an injury done to tendons, ligaments, fasciæ, &c., especially of the strain kind, impair the muscles more than when the muscles themselves are injured, so that these muscles appear to sympathize with those parts of little action, and become wasted and weakened in consequence. I think this arises from sympathy, or a consciousness of the parts being unable to answer to the action of the muscles, and it comes nearest to human reason of any thing in the body. If the affection be temporary, as in common inflammation, the muscles do not waste, being then conscious that the parts will recover. If one tendon is

materially weakened, the muscle will also; and then, if the motion of the joint depends on that muscle, lameness will be occasioned, and the other muscles will become also affected. If a joint recovers, the powers of the muscles begin to recover in proportion. This is the case after injuries of the joints, as fractures, or ruptured tendons; and the first intelligence of recovery in a joint will be the enlargement of the muscles. This is the case in paralytic parts, from the cutting of a nerve; the wasting is not occasioned by the deprivation of the nerve depriving it of nutriment, but from the muscles losing their power of exertion. If the hip is affected, the muscles of the leg or knee will waste, whilst those of the foot will not be altered, which would be the case was their wasting owing to want of nutriment from the nerves. If the elbow is affected, the muscles of the arm surrounding it will waste, whilst those of the hand will not be affected. When the muscles waste, in consequence of a disease in the joint, the surgeon will often say it is from want of action; but if he will only observe the other leg, he will find the muscles nearly of their full size, though they have had no more motion than the muscles of the diseased leg. The mind, likewise, loses its power over the muscles, for the will has never any power over muscles while the parts they move are unfit for motion, even although the muscles are not wasted.

The effects which a disease of a part has on distant parts.—Many diseases of this class produce diseases of debility, as for example, involuntary contractions of muscles, œdema, inflammation, and sometimes mortification in parts beyond them; thus, in a disease of the loins some of these effects follow in the lower extremities. Though they only arise while a disease is present, and is in its height, yet the disease may be cured, and the inability in the joint remain, as is the case in ankylosis. But here I may observe, concerning the contraction of muscles just mentioned, that it may take place together with these diseases, as in white swellings of the knee. But then it is very different from these diseases, the contraction proceeding from an endeavour of the muscles to adapt themselves to the state of the joint, whilst these are only like symptoms of beginning dissolution in the parts. This debility is not like common paralysis; the latter is a wasting of power in the muscles, from a want of stimulus; but this is a real disease from irritation. It is perhaps reducible to a species of sympathy similar to general hectic, from a local disease, and it may be called local hectic; but it sometimes goes beyond hectic, even to mortification.

Effects of local diseases on Joints.—Joints that have a secondary motion with the diseased part, from having muscles common with it, may be included. These joints gradually creep into the middle state of motion, but sometimes beyond this, so as to be more bent. Thus, the thigh is often bent forward, and also drawn more inward, so as to be immoveable, from diseased loins or hip. The knee also is frequently affected, even as if it was itself diseased. The limb first wastes; next is œdematous; and afterwards often inflames and

suppurates, which is sometimes very extensive. From continuation of one position, and want of action in the antagonist muscles, the joints, from necessity, become unfit for motion, and are afterwards often very imperfectly restored.

Exfoliation.—This is the separation of a dead bone from the living, and is not generally understood. By the term we should be led to suppose that only the common separation of scales from a bone was meant, for the other exfoliations are not answerable to the term. We have many opinions of this process from different authors, but all very imperfect. The bone that separates cannot come away by rotting, for it is only dead, and not in the least putrefied. Bone is composed of two parts,—an animal substance, and an earthy substance intermixed with the animal. Hard bones, and the hard part of bones, have a larger proportion of earth than the soft or spongy bones; they have also fewer vessels.

When a piece of bone becomes absolutely dead, it is then to the animal machine as any other extraneous body, and adheres only by the attraction of cohesion to the machine. The first business of the machine, therefore, is to get rid of this cohesion and discharge it. For effecting this separation there are several natural and successive operations going on.

The first effect of the stimulus is on the surface of the living bone, which becomes inflamed; whether new vessels are formed, or the old ones become larger, is undetermined; but by injecting the surface of the part it appears evidently much more vascular than the other parts. The surrounding parts also inflame, as the periosteum and cellular membrane, and often take on ossific inflammation. This produces another process: first, absorption of the earthy matter, and all the surface between the living and dead parts of the bone become as soft as if steeped in acid, while the dead part remains as hard as ever. To complete the separation, the absorbents continue their office, and absorb the living parts also, and the first process is in a small degree attended with the second. The operation of separation does not take place equally; it begins at the circumference, and continues on to the centre; and before the centre has begun the absorption of the earth, the circumference has begun the second. This progressive process in the suppuration causes the exfoliation to be tedious, so that the centre is the last place that separates. In pretty broad exfoliations, long before the centre has gone through the operation, the living parts perform their office, in producing granulations from the surface, and continue, in proportion to the waste, to fill up the space. When the dead part is wholly loose, it is, like all extraneous bodies, pushed up to the surface. It often happens that the granulations ossifying, the exfoliation is locked in at the edges, thus giving it the appearance of internal exfoliation. Thus, while Nature is busied in getting rid of that part of the bone which is dead, she is laying on additional bone on the outside, the intention of which seems to be that of keeping up the strength of the bone, which would, without this addition, be lessened by the loss of sub-

stance. This opinion is, I think, supported by this circumstance seldom occurring in this manner in any bones but those of the lower extremity, which support the animal. If this is true, it is a curious process, by which Nature endeavours to support the strength of these bones during a loss of substance, by throwing on the outside bone in proportion to the loss of substance within. Nor is the process by which this adventitious bone is afterwards removed less curious, and the piece of dead bone set at liberty; for from all that living bone adjacent to the dead piece, granulations arise, which push up the dead piece against the upper sides of the cavity; and in consequence of this pressure against the newly formed bone, the absorbents are set to work to remove it, and in proportion as this is absorbed the piece is pushed out, the granulations filling the space behind it. That in the separation of a dead piece a part is absorbed, I think is very evident; and that there is a loss of substance at the time of separation is obvious from this circumstance, that if a circular piece is taken out of the skull, and the circular edge of the remaining bone has its life destroyed by the actual cautery, to any distance, this deadened part will separate and come away, which it might not be able to do without a loss of substance between the living and dead bone. Another proof of the loss of substance in this supposed case is, that the side of the circular piece which is separated will retain its spiculæ, while the edges of the remaining bone, so far from corresponding with them, are quite smooth. Now, as there is room in this circular hole to allow the ring of bone to come out, its regularity cannot be the effect of new matter added between the spiculæ, but is in consequence of the absorption of those spiculæ. It appears from this last supposed case that it is my opinion that the absorption is of the surface of the living bone; but I by no means wish to be understood that no absorption of the dead piece can take place; for, on the contrary, I believe that Nature sometimes finds it necessary to the completion of her process; it generally takes place when the separation is slow, and the granulating process is quick. This absorption of the dead bone takes place in the fangs of the shedding teeth. [See note, p. 50.]

The first appearance of separation is an alteration in the part round the exfoliating piece. This alteration is first a sponginess; next, its becoming fuller of little holes; then a small groove is produced, a kind of worm-eaten canal about the thickness of a shilling, becoming gradually deeper and deeper: and the depth is irregular, according to the extent of the original cause. The small holes appear at first in the surrounding parts, and these appear more vascular, the more so the nearer the diseased bone. Sometimes parts become dead without any change of colour, dying almost suddenly, perhaps by exposure or a blow, and the surrounding part becomes spongy; the dead portion then looks the soundest; but when killed by previous diseases it is black. It is astonishing to see what little curiosity people have to observe the operations of Nature, and how very curious they are about the operations of Art.

After exfoliation, the living surface still continues soft until bone is formed. If it be a cylindrical bone, it has the appearance of a fœtus's bone deprived of its epiphysis: it is hollow, but fills like a growing bone, in every respect, by bony matter deposited. Hard bones exfoliate quicker than soft, and the harder parts of soft bones sooner than the soft: the bones of full-grown people sooner than those of the young.* If you lay a hard bone bare to any extent, it always dies, but not always if the soft ones. Situation has the same effects as in other diseases: in the foot or leg it is slower than in other parts less removed from the centre. In exfoliations we often find considerable pulsations in the matter, lying in a hole which communicates with the granulations, which are formed under the exfoliating bone; sometimes it is hardly perceptible; this will depend much on the state of the granulations, their health, fulness, &c.; if all these are joined, the pulsation is very considerable: also according to the proportion which the size of the hole bears to the granulations underneath. After trepanning, the whole expansion of the arteries of the brain becomes visible, by being seen at one point: so it is with granulations, when the quantity is considerable in proportion to the hole. This depends on mechanical principles; so it is with mercury in a thermometer; we see it rise when in the stem, while in the ball it would be invisible.

Exfoliation from accidents,—as from a blow, which is often of sufficient force to kill a sound portion of a bone, as in compound fractures, gun-shot wounds, at the ends of bones after amputations, &c., all of which do better than when it arises from diseased parts, the common processes of separation being carried on more vigorously.

Exfoliation from Disease, as Caries.—Disease is often carried so far as to produce death in a part of a bone, and exfoliation is often very salutary, but not always so. Surgeons have endeavoured to cure a diseased bone by killing it: but this is often not so salutary as when it is spontaneous; for in the latter the whole diseased part generally dies; but it is often the contrary, or partial, when it is produced by art. The actual and potential cautery have been used for this purpose, and the practice probably arose from an idea that all diseased bones were disposed to separate by exfoliation, and that this would hasten it; but exfoliation is not, as has been supposed, a necessary consequence of disease in a bone, but it is the death of the bone which makes exfoliation necessary, to separate the dead piece. Now caustics neither hasten the process of separation either here or in soft parts; but the actual cautery, indeed, often has the power of inflaming the living surrounding parts, which invigorates and stimulates them to what they were

* [The great attention which Mr. Hunter bestowed on all matters connected with diseases of the bones entitle his opinions to the greatest respect. Believing, however, that the bones afford no exception to the general principle, that the actions of parts are vigorous and rapid in proportion to their vascularity, I am compelled to dissent from the fact expressed in this paragraph.]

before incapable of, its use in this, and its superiority to the potential cautery not being commonly known. When the actual cautery can deaden the whole diseased part, a cure may be expected; when art is to be used it is uncertain, as the quantity of disease in a bone can seldom be known: however, at times it may be guessed at, and as the seat and thickness of the bone vary, the cautery must be varied also. If the bone is diseased deeply, the cautery should be much heated, and very thick, so as to retain its heat longer: but these means are often insufficient, and the disease goes on teasing the part a long time, particularly in the lower extremities. In cauterizing, it is better to burn beyond the diseased part than not enough. But its frequent failure has occasioned the use of it to be much laid aside.

Situations of Exfoliations.—There can only be two species of exfoliations, viz. external and internal; but they are often mixed, and then admit of a third kind, which I call the inclosed exfoliation. The external arises from internal causes, and is in many parts a simple operation, meeting with no obstructions, as in the head, ribs, &c. But in the extremities it is often complicated, and becomes inclosed, and then appears as an internal exfoliation.

Internal Exfoliation.—These less frequently arise from accidents than the former; but may arise from the two last suppurations of bones. The part which is to be exfoliated loses its life, and ulceration goes on in the internal surface of the surrounding living bone, to make room for the exfoliation.

In internal exfoliations a part of the centre of the bone becomes dead, while the enlargement of the cavity lessens the substance of the surrounding part, and consequently weakens that part. But Nature wishes to furnish a substitute; for the stimulus of weakness being felt, the surrounding parts become affected, and undergo the ossific inflammation, by which the bone is thickened; and this continues in proportion, and as long as the internal part is unremoved, or not cast off.

Mixed Cases of Exfoliation.—The first is when an external one appears to be internal; the second is an exfoliation of the whole thickness of the bone in one part; the third of the whole bone. These I call inclosed, or incased exfoliations, generally occurring in the lower extremities. These three being different at first, are not very easily conceived.

First species of Inclosed.—Sometimes when the surface of a bone becomes dead, before the separation of the piece of bone takes place, the ossific inflammation comes on, and entirely covers the exfoliating piece, leaving only a little hole for the discharge of matter. This takes place, first, when the periosteum is inflamed, and the granulations from the edges of the exfoliated pieces also ossify; but the process for freeing the portion of bone has been described already.

The second species is when a piece of any given length becomes dead throughout; the appearance of internal exfoliation is here

still stronger than in the last case. Exfoliation or separation begins on the living surface of contact, at the two ends of the dead bone or piece, and ossific inflammation comes on in the surrounding parts, so that it becomes incased. This rarely happens, but when it does, the separation of the exfoliated piece is very tedious, as the stimulus is given to all surrounding parts.

The third species is where the ossific disposition takes place in the soft parts, from end to end, and the whole becomes inclosed in a case of bone. The difficulty lies in conceiving how it becomes inclosed at the ends where the joints are constituted; but probably it is from these ends being alive, and exuding coagulable lymph from their surfaces, or else from lymph being exuded from the surrounding ligaments, and that becoming a basis, so as to keep the joint complete.

Of extracting Exfoliated Bones.—As it is uncommon for parts to heal before the exfoliated pieces are extracted, or if they do heal, not to break out again, their extraction becomes proper, if practicable; but this is often difficult in many cases, from the situation, as also from the obscurity respecting the real circumstances, of the exfoliated piece: but in internal and in the incased kinds it becomes still more difficult, even though all the circumstances attending the exfoliated piece were known perfectly. The surrounding soft parts render many things respecting bones obscure; but wherever the bones are found loose and bare, attempts should be made to remove them.

The pressure of a probe on a piece of bone will generally satisfactorily inform you if the part is detached, by its mobility. If detached, we may often gain time by removing it, and in general this is proper and the best practice. If it does not allow of a removal from its extent, it is best to break the exfoliated part into pieces: though it may be often difficult to ascertain this, as the edges are often covered with surrounding soft parts. The internal exfoliations, and also all the mixed species may be often assisted: but the difficulty lies in ascertaining the state of the incased piece, without which little can be done, nor should much be attempted. In the internal and mixed, which are not only covered by soft parts but also living bone, it will be difficult to ascertain. In mixed cases it may be evident that exfoliation has taken place, and is incased by bone; and for such, a dilatation must in order to expose some of the living bone. The next thing is to separate the dead bones; probably some of the living bone must be sawed through, (the best saw for which purpose will be one in form of an *axe*,) to allow of the extracting the dead pieces and such living parts as are broken off, which often happens; or the dead must be broken into many pieces. Both these I have done, as I will illustrate by a case.

A young gentleman had an abscess form about the middle of the arm; when this was opened, the bone was found bare. It was opened in two places; first, on the outside of the arm above, and

next on the inside below. The openings did not heal, and the bone could plainly be felt at both. He had been in this way some years, when he came to London. On examining the parts I could plainly feel the bone with a probe, and move it upwards and downwards a little, but at the extent of each motion it seemed to be fast. It was plain that the bone should be removed, if possible; but how was it to be done? I chose to expose the bone at the upper and outer orifice, this being less engaged with the nerves, vessels, &c., and also being more convenient to operate upon. An incision was made on the bone downwards and forwards on the outside of the biceps flexor; the end of the exfoliation was exposed, as also the upper part of the bony case. I followed this downwards and obliquely inwards, and when I had exposed the whole, I sawed it, in the direction of the exfoliated bone, to the exfoliation itself; but as this did not open so as to allow the disengagement of the bone, I put in the spatula to force it open, but could not; however, I did it in part, so as to get a wedge of wood into the opening, which kept its position. The next time I forced it open a little more, and pushed in a thicker wedge, and in two or three trials more I was able to bring out the exfoliated bone. It was a piece of the middle of the os humeri, about three inches long, and of its whole thickness.

Of Rickets, or the Constitutional Defects of Bones.—This complaint would appear either to be a fault in the general constitution, or in the principle of the formation of bones themselves; but as it is peculiar to one class of constitutions, which are all weak ones, it might be thought to arise from weakness. If weakness is necessary to produce this disease, it must be one attended with a peculiar disposition. And this is probably the case; for we can hardly suppose that such a disposition in the bones could produce this species of constitutional weakness. However, as it is a weakness attended with a disposition of a particular kind, it is possible it may arise from this fault in the bones, so far as the constitution sympathizes with the state of the bones. It is of a particular kind, as all weak people are not affected with it. This peculiarity of disposition, I suspect, is somewhat of a scrofulous nature, at least the two effects are often found in the same subject, whether the causes are the same or not. It would appear to be a want of power in the bones, or of disposition in their vessels, to form calcareous earth and animal matter, but less of the last than of the other. It is most common in young subjects, and is generally attended with enlargements, and the bones often bend from the incumbent weight. From the increase of size in growing subjects, it would appear that the proper quantity of earth is the cause of the limitation of size of bones, or that the bone has a greater freedom of growth when not checked by a due quantity of earth or its own solidity. This is more perceptible in the joints, as they are there softer than in other parts, and hence these parts are most subject to this disease. It is only in young and growing bones that this increase of size from the

deposition of the two substances can take place, it being only an effect; but a full-grown person may be rickety without any increase of size, their bones not admitting of it. The definition of rickets, then, is a deficiency of earthy matter in growing or full-grown bones. In the adult we see the bones bent by the action of the muscles.

But the cause in the adult is different, it being a disposition to remove what is already formed and deposited by absorption; however, a disposition to absorb would appear very different to a want of disposition to deposit, and may probably arise from a very different remote cause; for though the effect is similar, yet I can conceive both to have the same original cause. If a softening of the bone is to be the disease, it is only taking place by two different means; for as there is probably a constant replacement of the earthy matter, this disease may arise in adults from a want of power or disposition to supply the place of that which the absorbents remove.

Of Rickets in Adults [mollities ossium].*—The disposition to absorb the hard substance of a bone, or the disproportion between the process of deposition and absorption, which produces rickets in adults, is often in a much greater degree than in young subjects; for in the most rickety child I have always observed some earth in the bones, but in adults I have seen the bones become as flexible as a tendon almost. In different parts of the bone we find different dispositions; but the disposition of absorption gets the better of the ossific disposition in other parts of the bone, or of the disposition to deposit earth.

Of the Effects of Mechanical Pressure and Muscular Contraction on Rickety Bones.—The bones are often bent by mechanical pressure of the body, and by muscular actions, into very peculiar forms,

* [Mollities ossium differs from rickets in respect of the age at which it occurs, being a disease of adult age affecting the whole of the bones, whereas rickets is a disease of childhood which is principally manifested in the bones of the lower extremities and spine, and but rarely in the bones of the pelvis or upper extremities. They agree, however, in this, that when a section is made, the bone is found to be more cellular than usual, the cortical part is reduced to a mere shell, the cells are filled with a bloody or gelatinous-looking substance, and the deficiency of earthy matter is such that the bone is easily divided with a common knife. Dr. Bostock found in some instances of mollities ossium that the quantity of earthy matter was not more than one-fifth, instead of being two-thirds of the weight of the bone. It may further be observed that the disposition to mollities ossium is rarely overcome when once formed, but the disposition to rickets is generally worn out as children grow up; and, in proportion as this happens, the long bones at the seat of curvature are found to be flattened laterally and strengthened on the concave side, where the support is required. Fragilitas ossium, depending on the superabundance of the phosphate of lime in old people, accompanied with a disposition to ossific deposits in the different structures of the body, may be considered as a vice of nutrition of the opposite kind. A remarkable case of this sort of ossific transformation of the muscles and other structures is preserved in the Hunterian Museum, in which the movements of the patient must have been as effectually manacled as by the enchanted wand of Comus.]

and often impede the actions of other parts. The joint forms a more acute angle than it would in health, and then the muscles get a greater power of action. It is most frequent in the back-bone, pelvis, and thigh-bones, in the angle made by the cervix femoris, knee, tibia, &c. In these it is most frequent, from the two powers acting (viz., weight and muscular action). The ribs are made straight, or rather bent inwards, by the pressure of the atmosphere, so that the child can hardly breathe; a bad formation of the skull will affect the senses; crooked spine will affect the health from an alteration in many of the viscera. In the female pelvis many dreadful consequences occur in delivery. When a bone has admitted of a bias, a disposition takes place on the side unnaturally pressed, for a deposition of bone, so that we find a bony substance formed there which acts as a prop.

In the leg the bone is bent forward from the muscular action behind. We have seldom these bends in the upper extremities, as only one of the powers is acting, viz. that of the muscles: however, they are sometimes bent, as an example of which an os humeri was shown. In the thigh the curve is generally forwards and towards the upper part, as was seen in an os femoris in which Nature had deposited a quantity of earth on the concave part. Rickety people are generally knock-kneed, from one condyle being less than the other; it always is somewhat less, unless in bow-legged people. Bow-legged people are in fact straightest with respect to the bones, the femur and tibia in them being in a straight line.

Of the Cure.—The cure is not yet discovered, nor is the preventative of absorption in the adult yet known. The original cause being the same in both, the treatment should be the same. The indication is to give strength and tone to the system by bark, sea-bathing, &c.; but these only seem to give general health. However, I have the greatest opinion of sea-bathing, bark, and chalybeates.

Of Exostosis.—This is in a great measure peculiar to youth. It is an increase of bony matter in particular parts of bones. It is of two species: one is local, and may be supposed to be similar to many tumours growing in the flesh, and probably may occur in any constitution; the other requires particular constitutions, and seems to be constitutionally interwoven with the formation of bones in such people. They are principally connected with the soft parts of bones, appearing generally at their extremities. When universal, the whole soft parts of the bone are affected. It sometimes appears suddenly, and is of various figures, sizes, &c.; but sometimes it comes on gradually and increases gradually. These protuberances often swell to a considerable thickness beyond their origin or attachment, by which means a small neck is formed. Sometimes they have a power of growth within themselves, and do not in all cases continue to grow from their origin. Sometimes it affects only one bone, at other times almost every bone in the body. It is a shooting out of bone from a bone, as the horns of a buck's

head. It is not the effect of ossific inflammation. The substance of the bones in these constitutions is often enlarged in the soft parts, as in rickets, which leads me to suppose the same original cause is common to the two diseases.

When near the joints it often produces lameness, and disturbs the action of the muscle so as to alter the motion of the joint. The cases of a gentleman and lady were mentioned who were subject to the former of these processes, which was very troublesome; the lady was evidently scrofulous.

Cure of Erostopsis.—As it appears to be more connected with the natural formation of bone than with disease, it is of more difficult cure than if it arose from disease; for disease is always producing action tending towards a cure. It is hardly ever to be cured by medicines either external or internal; but as it is sometimes spontaneously removed, we should endeavour to promote the absorption of it, by rousing up this power. If, however, we are not masters of this power, and we know of no such, they may be removed by art, if this can be done with safety. The situation first should be well understood, and the parts covering it well known. The instrument must be adapted to the kind of exostosis and to the situation; the common ones are a saw, cutting pincers, and chisel. First lay the part bare, either by removing a part of the integuments, or by making the incision somewhat longer than the tumour, so as to make more room, after the separation of the lips, for its removal. If anything more than skin covers the exostosis, as muscle, it should be only divided, not removed. When there is a hard root, and deeply situated, a cutting pincers or chisel is necessary; but if superficial, as on the tibia, it may be sawn off. I have removed them from under the deltoid muscle, and also from the tibia. The immediate dressings must be suited either for healing by the first intention or by granulations from the bottom of the bone. If the first, exfoliation may take place; but this is of little consequence, therefore it should generally be attempted, as it frequently will succeed; and if not, suppuration ensues, and it is easily and speedily thrown off.

Diseased Exfoliations of Cartilages.—Cartilage is a peculiar animal substance, and composed wholly of animal substances, coming nearer to horn than any other structure. I divide them into two kinds: first, such as constantly change into bone at a certain age; secondly, such as do not change into bone, as that of the nose, ears, &c. They appear to have but weak powers.

When there is a fracture, the union is bony by ossific inflammation in the cartilages, which change into bone; but in the permanent cartilage there is a renewal of its own substance. Sometimes the inflammation goes on to suppuration; but they seem to have insufficient power to admit of ulceration: yet they may be absorbed by the absorbents of other parts; as in white swellings, when suppurated, the cartilaginous ends are removed by the absorbents on the surface of the ends of the bones that the cartilage covers.

It may be ulcerated in this manner in other joints also ; in the knee we find all the different stages of absorption of cartilage ; granulations will shoot from under, through the cartilage, and sometimes when there is not much matter in the joint, these granulations will inosculate and form a bony union. [*Preparations of cartilage were shown peeling off the ends of bones.*]

Changes of Cartilages of Joints by exposure.—The only effect seems to be that they become softer, which is occasioned by interstitial absorption, which sometimes proceeds so far as to remove the whole and leave the bone bare ; a case of which was given in the finger after amputation. When the cartilage is exposed, the surrounding parts granulate and surround the cartilage like a purse, not adhering to it for some time after the wound is healed, for cartilages will never heal by the first intention. A woman had her arm amputated at the shoulder-joint, with a flap by Mr. Bromfield ; and in two years afterwards she died of a fever in St. George's Hospital. Upon examination, I found that the cartilage had not adhered to the flap, which in that part had a smooth surface ; nor had any granulations arisen from the surface, which appeared unaltered.

Exfoliation of Cartilages.—The separation of a dead part is called exfoliation, for there can be no ulceration of cartilage. However, this is very uncommon, as the absorbing powers are very deficient in cartilages to remove dead parts. I have never seen it. I have seen them black and dead, but then the whole cartilage came away, together with the end of the bone ; therefore it could not be called exfoliation of cartilage from cartilage, but of bone from bone. But the cartilages are capable of being absorbed from the granulations formed under them on the surface of bones. The permanent cartilages are just similar in their separation, &c. I have seen them separated in sores of the part, as the nasal cartilages.

CHAPTER XIX.

OF HEMORRHAGES AND ANEURISM.

Causes of hemorrhage.—Hemorrhage: 1st, natural; 2d, diseased;—arising from irritation;—stimulating styptics to be avoided;—occurring on membranous surfaces;—3d, from wounds;—checked by contraction of arteries;—artificial modes of checking hemorrhage;—oil of turpentine.—Coagulation of blood;—stretching of arteries;—ligature;—modes of applying it.—Secondary hemorrhage.

Of aneurisms;—true and spurious;—different kinds of each according to authors;—divisions fanciful;—definition of an aneurism.—Cause of aneurism; experiments on coats of arteries.—Situation of aneurisms.—Action of heart not the only cause of aneurism;—local disease in the artery; and want of equable support round the vessel.—Natural cure of aneurism from obstruction of the artery;—œdema of the limb;—sloughing of the skin over an aneurism.—Treatment of aneurism.—Objections of Pott and Bromfield to operations for aneurism.—Strictures of the latter on Mr. Hunter's operation.—Necessity for early operation;—improper practice of waiting for the dilatation of collateral channels.—Mr. Hunter satisfied of the propriety of his operation;—arteries on which it might be practised.—Mode of operating where a tourniquet cannot be applied;—when it can.

From what we have said of the blood, it must appear to be of great consequence that it should be distributed to every part of the body in its due proportions; but in disease a much nicer proportion is necessary than in health.

Effusions of blood arise from three causes: 1st, from natural causes; 2dly, from disease; and 3dly, from violence. Of the first species is the menstrual discharge. The second kind arises from many diseases both constitutional and local: those from the constitution are numerous, as bleeding at the nose, &c., which often appears to be a species of derivation, or the effect of a diseased action on this part, as is sometimes the case in piles, where they may be considered as produced by the constitution; those from local causes may be called spontaneous, as bloody flux, bleeding from piles, vomiting or spitting of blood, diseased menses, &c. The third proceeds from violence, destroying the continuity of the vessels, among which must be classed aneurism.

Of Hemorrhage from Disease.—At present I shall only speak of the second and third hemorrhages, from disease: these I have divided into constitutional and local. The constitutional should in general be encouraged rather than checked; but the local are next to our present purpose. The local arise from two causes: 1st, from a peculiar irritation, which can be cured only by quieting the irritation; or, secondly, from a species of relaxation, or want of power or action, in the vessels of the part. The first I have seen in many operations, when a new irritation had taken place; as

when the divided vessels had contracted and checked the bleeding, they have opened again on the application of a cautery near them. The intention of this would appear to be the removal of the extraneous body; it also occurs in many wounds and sores which do not secrete good pus, but pus mixed with blood.

For the cure of this species, instead of styptics, we should apply sedatives, the best of which is opium; and sometimes, probably, solutions of lead. The effect of these will be according to the peculiar irritation. A boy, for instance, had a bloody sore on his shin from an accident, for which he first used a common poultice; but as it still continued to bleed and not to heal, I ordered a poultice made with poppy-head decoction, under which it went on well, and soon healed. Nothing affects the system more than too great a loss of blood; the body becomes languid and cold, and the heart seems disposed to suspend its action, as if a natural method was instituting to stop the bleeding, and also to keep the actions of the machine proportionate to its power. But I know not what the cold sweating is to do. An animal cannot subsist long in this state but the constitution will begin to rouse up its actions again; there will be a full pulse and seeming strength; but if the weakness is very great, this apparent action or reaction of the system does not long continue. When the pulse is strong and the body warm, it would appear an indication for bleeding; but this is improper, and the loss of a small quantity of blood at this time would probably kill the patient.* The rising of the pulse in hemorrhage is often an effort of Nature to live, and cannot be reduced, although it still further increases the irritability of the system.

Hemorrhage from the second cause always exists in the small vessels, and commonly in the membranes of some outlet or excretory duct, and also in sores which have become in some measure like those secreting surfaces. It probably arises from a want of disposition to contract. The cure is the same as that from violence viz. the application of powdered resins, oleum terebinthinæ, and other styptics.

Of Hemorrhage from Violence.—All wounds do not admit of union by the first intention, as when a large vessel is wounded, when the second mode of union is necessary. But large vessels are sometimes wounded without much harm, which either depends on the mode of division, or their situation with respect to surrounding parts. The bleeding from vessels has in many cases a good effect, as in fractures, and is then in small quantity; but when copious it hinders this salutary effect, as is sometimes the case in simple fractures, and commonly in compound.

The suppression of Hemorrhage is effected by three modes, viz. the natural, the accidental, and the artificial.

* [Dr. M. Hall has amplified on this observation in an able paper in the seventeenth volume of the Medico-Chirurgical Transactions, in which he has pointed out the dangerous consequences which may arise from mistaking the reaction consequent on repeated losses of blood for an indication for further depletion.]

The first is from the contraction of the muscular coats of the arteries: this power is one of the natural ones, and the accident is the cause of this contraction by its stimulus. It is most powerful in the small vessels, as the blood's motion is less in them; but even in large vessels it is considerable. I am of opinion that an amputation below the knee in most cases would not kill by its hemorrhage, even if left to itself; but this experiment can only be ascertained by accident. The artery in the thigh of a boar stopped bleeding before the animal was at all weakened, and the carotid artery of an ass also stopped bleeding after being divided: but I believe that the arteries of most animals have more of this power than those of man. It sometimes appears as if this contraction was not permanent, but relaxed and contracted at intervals; but when vessels repeatedly bleed there is probably a want of contractile disposition, for then the whole surface is bloody, and the patient becomes very weak from the loss of blood, and often dies. This contraction of the vessels can be increased or diminished according to circumstances. The first cause of increased contraction is exposure, which is very evident in operations; for when the wound is dressed it will bleed again, and again cease when exposed, so that here the contraction must be from exposure. I conceive that leeches occasion a free discharge of blood by their having a specific power or acting as a poison on the vessels, so as to weaken them and prevent their contraction thereby.

The assistance which may be given to the natural contraction is by means of stimulants, which, however, can only affect the small vessels; their action is simply stimulating them to contraction. Whatever stimulants are used, they will be assisted by the power of the vessels and their sympathy with each other. A dossil of lint dipped in oil of turpentine, after having first wiped the wound clean in order that it may reach the vessel, is the best, and may be renewed pretty often. I have seen it immediately stop vomiting of blood from the stomach after all other means had failed [see p. 254], given internally with white of egg as often as the stomach would bear it. In external hemorrhages where it had not the desired effect applied externally, I would give it internally: it is the best, if not the only true styptic; thus, in a case of nasal hemorrhage which nothing would stop, I gave ten drops of oil of turpentine in a draught, and repeated it every two or three hours, which entirely stopped the bleeding in less than twenty-four hours, and it never returned.*

* [It is scarcely necessary to observe, in the present day, that this eulogium on the oil of turpentine is unmerited. Of external styptics, (if any really deserve that name,) a saturated solution of alum is much to be preferred; and certainly no internal medicine has equally acquired the general confidence of medical men as the superacetate of lead conjoined with opium.

The arrest of hemorrhage is attended by the following circumstances: 1st, the retraction of the artery within its sheath; 2d, its diametrical contraction; 3d, the effusion of blood into the cellular spaces between the vessel and its sheath; 4th,

The second, or accidental, mode is of two kinds: first, the coagulation of the blood as it flows, not within the mouths of the arteries, as has been always described by authors, but around them. This can only take place when the arteries can contract a little into the surrounding cellular membrane by which the blood is divided, and this assists its coagulation; and the pressure of it on the mouths of the bleeding vessels assists in stopping the hemorrhage. This disposition can be increased by spongy bodies applied to the mouths of the vessels; in some cases lint is sufficient, and flour will assist the lint; cobwebs also are useful on the same principle, and the process of coagulation will also be increased by agaric, from its increasing the surface of coagulation, as well as by its pressure on the vessels; but these can only be useful in wounds of small vessels, where the circulation is slow, so that the blood can coagulate, and are improper in wounds of the larger vessels. The tourniquet may be applied here, but it should not be twisted too hastily.

Another mode arises out of the natural, and may be considered in some degree as natural. It is a property in flexible bodies to have their diameters contracted as they are lengthened; in arteries this might be carried to a great degree when permanent effects are to be produced. It is necessary that they should be lengthened so much as to destroy the contractile power; for this is the way Nature takes to stop the bleeding of ruptured vessels. Thus we see that arteries which are lacerated will more readily stop bleeding than if cut with a sharp instrument, as was proved in the case of the miller related by Cheselden; and this is the way Nature takes to stop the bleeding of the navel-string in beasts. Surgeons do not take advantage of this; but farriers and gelders do, as their practice of tearing the artery through in gelding animals shows.*

the formation of a coagulum or plug within and around the vessel; 5th, the effusion of lymph; and, lastly, the contraction and obliteration of the cavity of the vessel to the next principal branch, and its final degeneracy into a ligamentous cord.]

* [The principle of *torsion*, as practised by several of the French surgeons, is precisely the same as that which is here laid down in respect of lacerated arteries; that is, the extremity of the artery is drawn to a point, and does not return to its original calibre, in consequence of the destruction of its elasticity. We may also further add, that the rupture of the internal and middle tunics, which generally happens on these occasions, will tend to occlude the mouths of the vessels still more completely by entangling the blood among the lacerated fibres and promoting its coagulation. But how far the first of these effects, or the obliteration of the calibre of the vessel, depends on the destruction of any vital property, as of muscular contractility, may well be questioned, since the same effect takes place on dead arteries when similarly treated.

A preference is given by some surgeons to this means of arresting hemorrhage, inasmuch as it obviates the necessity for ligatures, and does away therefore with one cause of obstruction to union by the first intention. Torsion, however, is objectionable: 1st, because it cannot generally be depended on where large arteries are concerned; and 2dly, because it requires a considerable isolation of the vessel from the surrounding parts, and sometimes leads to a sloughing of the extremity of the artery, which must operate as a much more dangerous foreign body in the wound than a simple ligature.]

Of lateral Wounds in Arteries.—The lateral wounds in arteries are commonly, though improperly, called false aneurisms, on account of the formation of a tumour with pulsation; it having been supposed that only the external coat of the artery had been wounded, and that the internal had given way in consequence of having lost the support of the external coat; but the fact is that the blood escapes into the cellular membrane, and, coagulating there, forms a kind of sac, cutting off all communication with the other cellular membrane, and, assisted by external pressure, may stop the bleeding for the present; nay, the wound may heal up by the first intention; but by constant and increasing pressure, the surrounding cellular substance, containing the blood, by degrees gives way and forms a perfect cyst. These may be divided into two stages; first, while the case is yet recent; secondly, when the cyst is formed.

The first of these will either kill or come to the second, if not operated upon; after which, if the operation is not performed, the patient must die; therefore it is best to perform the operation as soon as possible, as the second will also kill if not operated on. In the first stage, then, if possible, the artery should be taken up. The operation is very simple: first apply the tourniquet, then lay the artery sufficiently bare, and tie it above and below the wounded part; the part included between the ligatures will, when it becomes dead, slough off, therefore does not require to be cut out. The ligature should be first made on that side of the artery next the heart, and the tourniquet then slackened a little, to satisfy the surgeon of its safety; afterwards the whole should be dressed as a recent wound.

Of the artificial Means of stopping Hemorrhage.—The method is to stop the mouths of the bleeding vessels; but this is often very difficult, on account of the vessels being hid by being deeply-seated, and is made more so by the continuation of the bleeding, especially in a part where a tourniquet cannot be applied. I shall consider the artificial means employed for this purpose under two heads: 1st, chemical; 2d, mechanical. The first acts by destroying the natural texture, and of course the life, of the mouth of the vessel. The most powerful of these is heat, viz. the actual cautery, which should not be too hot, nor should it indeed be used at all unless other means fail. It acts by drying and coagulating the blood, and destroying the life of the part to which it is applied.* The iron should be thick, not too short, as large as the part will admit of, of a reddish heat or approaching to it. Concentrated acids have been applied with success, and whatever assists in coagulating the fluids, as ext. saturni; and I have sometimes thought of trying boiling water.

The mechanical method of stopping bleeding is by compression, and is the most secure: we therefore have recourse to it when

* [Besides this, the actual cautery corrugates and shrinks the animal textures, by which the bleeding orifice is obliterated. A similar but less powerful effect is produced by the mineral acids.]

every other means has failed. It consists in inclosing the vessel in a ligature. The spasms and convulsions which appear after operations, have been attributed to the nerve being inclosed with the artery in the ligature; but this seems false, it being only in particular habits that such symptoms occur, patients more generally recovering after the use of the ligature with no bad symptom than otherwise. I have sometimes tied nerves on purpose along with the artery, particularly along with the radial artery in amputations of the fore-arm, and never observed that any bad symptom succeeded.*

There are two methods of applying the ligature, viz. the needle and the tenaculum; the last cannot be employed on all occasions, only under particular circumstances. But the needle admits of application on almost all occasions. It has been objected to as taking up surrounding parts; but this is essentially necessary in old persons, where the arteries have lost their elasticity. An artery in the centre of a muscle should be taken up by the needle. The tenaculum should only be employed where we have sound arteries to deal with, and when these are situated in the interstices of muscles. If the artery is in the substance of a muscle, the tenaculum would take in more of the surrounding parts than a needle would do, and the ligature will be less secure. I think the ligature should be larger than it generally is made: the proper tightness is not easily ascertained; but it should be drawn more tight in proportion to the bulk of the parts inclosed. The degree of force used in this case would cut through the artery alone. The size, consistence, and roundness of the artery, and quantity of surrounding flesh, must direct us in the force which is necessary to make the ligature. The thicker the ligatures, the greater surface they compress. In small arteries the ligature need not be tight, slight compression answering the purpose.

Of secondary Hemorrhage after Operations.—This happens more particularly to the large vessels, and generally occurs a few days after the operation, owing to some circumstance or accident therein: the ligature not having been made tight enough, or else too tight; or from much surrounding parts being included, and some of these ulcerating, the ligature gives way. If there is not a loose tourniquet about the limb, the patient may soon bleed to death, or the bleeding lays the foundation of future disease, as lingering

* [It can scarcely, I imagine, be necessary to warn the reader against so slovenly a practice, which may be attended with the most painful and dangerous consequences. In every case it is desirable to secure the extremity of the vessel as distinct from the surrounding parts as possible, which will not only lessen the irritation, but be the best security against the occurrence of secondary hemorrhages.

The ligature should be of as small a size as possible consistent with strength, and be drawn with sufficient strength to cut through the internal tunics, which will then heal as incised wounds in other situations: but an artery which is diseased or inflamed becomes brittle, and will not bear the same strain as a healthy vessel.

weakness or dropsy. This secondary bleeding is very difficult to be stopped, especially when granulations are formed, as the artery at the bleeding part cannot be seen. However, an anatomical surgeon will not be at a loss to know the situation of the vessels; but admitting this, even then, the taking up an artery far above the surface of the wound will be a considerable operation. It will be right however, especially if the extremity of the artery be supposed to be diseased, to lay it bare above the diseased part, and then take it up where it is sound.

A. B. came into St. George's with a white swelling, for which it was thought necessary to remove the limb. Instead of granulations ulceration came on: the artery bled at times; but before any one could come to his assistance it would stop: at length, however, the bleeding was so great that he was considerably weakened, and soon died. Upon examining the limb the artery appeared sound, till we got within an inch of the stump, when it appeared black, and seemed to have lost its elasticity: the circumstance of the bleeding stopping and returning again, I am inclined to attribute to the patient's being low and faint at the time he was losing the blood, but returning again on the recovery of his strength. In these cases a diseased artery should be suspected; and I think it would be best to dissect for the vessels, and see whether it be so or not, and if found diseased, to take it up in a sound part. It is recommended by some surgeons to make a strong compression on the stump, which may be done by means of a thick pad, covered over with tin, and applied to a screw tourniquet, to prevent bleeding; but I would observe that the long pressure of the tourniquet is painful and inconvenient. Exposing the stump to cold air will at times stop the bleeding. These secondary bleedings as far as my observation goes, happen oftener to the radial and ulnar arteries than any other. The artery not healing by the first intention may be attributed to various circumstances, as ossification, extreme weakness, or the neighbourhood of a considerable branch.

OF ANEURISMS.

The injuries and diseases of arteries, called aneurisms by authors, are so various as to render it impossible to give a definition of them. They have been divided into true, and false or spurious aneurisms. The true, by Le Dran, are divided into three kinds, and Heister multiplies the division greatly. Le Dran's first is a regular dilatation of the coats of an artery; 2d, where one coat has given way, and the other coat, unable to sustain the force of the circulation, allows itself to be dilated; the third is a mixture of these two. The false are numerous divided by Heister and others: one is a true aneurism burst; another is a wound in an artery, which will produce various effects according to the treatment, all of which

are called so many aneurisms ; but I do not consider a wound in an artery an aneurism, even if an aneurism itself. Heister gives us the size of aneurisms as described by authors, which is only showing us the ignorance of those authors in allowing them to come to such a size before the operation was performed ; but I wish never to see one that can be made the subject of an operation larger than a walnut before it is operated on. I have already shown that a wound into an artery is not an aneurism ; so that I conceive there is only one disease which is properly to be called an aneurism, viz., the first, or true : nor is this divisible into different kinds ; the second kind is only ideal ; and the third is the consequence of one part of the sac giving way sooner than another.

By an aneurism, then, I understand the dilatation of the coats of an artery, arising probably either from disease or accident, producing weakness, which becomes the remote cause, while the force of the circulation is the immediate cause. It probably may also arise, however, from a disproportion in the blood's motion, and then the disproportion between the force of the circulation and strength of the artery is both the remote and the immediate cause ; but this is probably only in the larger arteries, where the force is greatest. However, whatever may have been either the remote or immediate cause, it must in fact in all cases arise from a disproportion between the force of the blood and the strength of the artery, the coats being weakened so as not to be able to support the force of the blood in its passage along its canal, which therefore gives way. This weakness of the coats of the artery would appear, in most cases, to depend on disease ; for accidents, *cæteris paribus*, have generally the powers of recovery. As a proof of this, I will relate an experiment made to ascertain the truth of the existence of the mixed kind, which was supposed to arise from a partial destruction of the coats of an artery, and that the remaining coat being too weak to sustain the force of the circulation, gave way, and distended. That the artery might have the full force of the blood's motion, I chose the carotid artery, as being near the heart.

One of the carotid arteries of a dog, for an inch in length, was laid bare, and its coats removed, layer after layer, until the blood was seen through the remaining transparent coat, and I had gone as far as I dared ; I then left the artery alone for three weeks, when I killed the dog, expecting to find a dilatation of the artery, as had been asserted ; but to my surprise the sides of the wound had closed on the artery, and the whole was consolidated to and over it, forming a strong bond of union, so that the whole was stronger than ever.

Mr. Cruickshank has, I think, produced an experiment in opposition to mine, where, after the artery was denuded and thinned, the parts surrounding it were kept from uniting with it, and an aneurism formed : but this experiment does not apply here ; for in what instance could such an alteration be made in the artery, and the surrounding parts not unite to it ? So that the blood's motion

was insufficient to produce the proposed effect. The force of the heart, however, has some power in operating as a remote or first cause of aneurisms. Aneurisms are most frequent in the larger arteries, as at the arch of the aorta; and more frequent in the second order of arteries than in the third; but they are sometimes found even in the fourth or fifth. I have seen an aneurism of the arteria pudica where it was passing out of the pelvis, and in which we must suppose a previous disease of the artery, as the force of the heart is small. The nature of the artery contributes likewise, the structure of the large arteries being chiefly of elastic matter, and not near so muscular as the small ones, which have therefore greater powers of resistance. It would appear that there must be a specific disease of the artery in most cases, for dilatation is too local for so general a cause as the force of the heart.

As aneurisms have hitherto been allowed to go on till they have either destroyed the use of the part, or killed, little has been known with regard to their nature or manner of appearance at first. Instances discovered in dissection have given us the only insight into their original appearance. In several which I have seen there was a pretty regular dilatation of the coats of the artery; but in many there was great reason to believe it began at one side. If we were to form our ideas of the first formation from the appearance of those of long standing, we should suppose the dilatation always began on one side; for when we open an aneurism that is very large, and examine the internal surface, we find that the coats of the artery are commonly still remaining on one side of the sac and not on the other; but I suspect that the appearance arises from the dilatation going on faster on one side than on the other after the artery has been considerably distended, which may arise from the vessel being not equally diseased all round, or being more exposed to the force of the heart on one side than another, or less supported by surrounding parts.

From the knowledge of the greatest force of the heart in the different arteries, and from the knowledge of those arteries which are not equally supported on every side, let us see if we could not, *à priori*, say where the swell would be, if such and such arteries were diseased on every side equally, and became considerably dilated. First, in those arising from the force of the blood's motion; for instance, when an aneurism takes place at the curve of the aorta the dilatation is upwards, because it is there that the blood pushes with most force, passing in a straight line when in the ascending aorta at the fore part, and when in the beginning of the descending at the back part. When in the carotids, the swell is outwards and forwards, because there is less resistance; in the subclavian, forwards; in the axilla, backwards; in the abdomen and thigh, forwards; in the ham, backwards; but in the leg, on which the pressure on the artery is equal on all sides, it is difficult to say on what side the swell would be, and hence it is that the bones of the leg are so often diseased when aneurism happen there, caries or ulceration ensuing when the

dilatation increases to a considerable size. Even in the last-mentioned situation the force of the heart directs, in some degree, the swell of the tumour; but that is not until the sac is a good deal enlarged. The force of the blood against the most distant part of the sac endeavours to carry it on further in the direction of the motion of the blood, which in time makes a pouch; therefore it is elongated in the direction of the sound artery. The sac often, by its increase, presses on the sound part of the artery, and becomes the cause of its obliteration, as I have seen more than once. Hence the blood becomes irregular in its motion, and has time to coagulate, till the sac becomes filled with coagulum, which is strongest and densest on its external surface. The coagulation takes place at the most distant parts from the direct current of the blood; the firmness and colour of the laminæ in different parts of the tumour are such that it is easy to distinguish an old coagulum from a new one; the external laminæ are of a dusty brown colour, and these laminæ grow gradually redder as we advance inwards towards the current of the blood. As the dilatation increases, the coats of the artery are either thickened by the thickening process, or the cellular membrane already thickened becomes firm, and adheres from a consciousness of weakness. When the aneurism proceeds to this state it generally gives way to the circulation.

It must be observed that the force of the blood on the sides of the sac diminishes in an inverse ratio to the increase of its sides,* which therefore are longer in dilating than might be imagined; but after proceeding to a certain length the adventitious coat gives way, and the blood is effused into the surrounding cellular membrane, producing distention; and when the artery is a considerable one, there is an obstruction to the blood's motion in the collateral branches, producing mortification. When the artery opens externally, it is always on that side where the artery gives way most. The ultimate effect of such events will vary somewhat, according to the situation of the aneurism; thus, if it be of the carotid artery the effusion on its bursting will soon occasion suffocation, &c. When an aneurism is in an artery whose dilatation brings it to the skin, the coagulum comes first, and obstructs the circulation in the skin: the skin inflames and mortifies, forming a black slough, which dries and adheres to the coagulum. As the slough separates, there is an oozing of blood at the edges, which becomes more and more, till at last in a large artery, as the aorta, the plug may be wholly pushed off, and the patient die instantly. If in a smaller artery death will be more gradual.

* [The author does not seem to have been acquainted with the hydrostatical law of equal pressure contained in the following words; viz., that when a quantity of fluid contained in a vessel is submitted to compression, the whole mass of the fluid and the whole surface of the vessel, however large, is similarly and equally affected: consequently the enlargement of the sac can make no difference as to the quantity of pressure which any given portion of that sac has to sustain. See Arnott's *Physics*, Vol. I., p. 242, 4th edit.]

Of the Method of Treatment, with the Opinions of Messrs. Bromfield and Pott.—This disease, if not attended to, is as dangerous as any that can affect the human body, because it is such as must always, even in the smallest arteries, kill; for as it arises from disease, the artery has neither the disposition nor power to relieve itself. Death must therefore be the consequence, either from the bleeding, or the consequences arising in the parts into which the blood is effused. Nor does it appear that the artery, either above or below the swelling, where it is sound, takes the alarm, or is stimulated to action; so that there is no resource, and death is the consequence. However, this disease is often capable of removal. When increased to a large size it is a very difficult operation; but I should wish it to be performed when the tumour is small. Messrs. Bromfield and Pott have written on this operation, and their opinions being different from mine, it is necessary that I should defend those opinions which I have adopted, and which I have spread abroad.

Mr. Bromfield objects to every operation, either amputation, or for the aneurism; this would be just if what he asserts was true, viz., that the whole of the arterial system is in general diseased, which however is certainly not the case. He says, too, "that the injecting of parts in dead bodies having shown that in particular subjects the branches sent off have now and then formed anastomoses with other branches given off lower down, has led to very extravagant notions of the smaller branches being always able to carry on the circulation; and an extravagant proposition has been suggested by some people to tie up the principal trunk of an artery in the extremities. I once saw an attempt of this kind in a true aneurism of the ham, in which I shall only remark that the patient died; and I do believe that the embarrassments which occurred, as well as the event of the operation, will deter the gentleman" (meaning me) "who performed it from making a second attempt in a similar case." Now, unfortunately either for Mr. Bromfield or myself, this is the very case from which I have formed favourable ideas of the success of future operations of a similar nature. Mr. Pott, after describing the disease in its last and most violent stage, just preceding dissolution, and when it has done all the mischief it can do without destroying the life of the patient, says, "If a man was to be asked how the disease was to be treated, he would answer, from theory, that the artery should be tied above and below the tumour, and the coagulated blood be evacuated; but that the artery is generally diseased some way above the dilatation, especially the popliteal." He also observes, "that the want of collateral branches of sufficient size to carry on the circulation is another powerful impediment to the operation."

When the aneurism has arrived at the stage which Mr. Pott describes, perhaps the only thing is to amputate above the dilated part of the artery: but Mr. Pott should have considered, that before these threatening symptoms there is a stage when all the surround-

ing parts are sound. If this be true, would any man allow a disease in a part to go on till the surrounding parts are diseased and past cure?

The events of all diseases are of two kinds : first, where the termination is certain; 2d, where it is dubious. The aneurism is of the first kind; its event is certain. Now I do aver, then, that there is a stage of the disease in which the operation is safe. I do not, certainly, know how to judge of this state from the external appearance, but from what I have seen of aneurisms, I believe it will allow of considerable latitude. My opinion is, that the operation should be performed, 1st, when the disease has done no mischief to the surrounding parts; 2d, where it is distinct and circumscribed, not connected with parts which may not be curable when exposed, as bones; 3dly, when there is a distinct pulsation. How early the operation may be performed I do not certainly know, but my opinion is that it may be done as soon as the aneurism is known to exist. By some it has been recommended to permit the disease to exist some time first, because, say they, as the circulation becomes obstructed, a freer communication will take place between the branches above and below; but this would not be until the obstruction had subsisted some time, and I would not wait for this, for fear of the consequences described by Mr. Pott.

When the disease is in an advanced stage, I agree with Mr. Pott in thinking amputation necessary and preferable, but not under the circumstances above mentioned. The earlier, therefore, the operation for the aneurism is performed the better, not waiting with the expectation that an increased size of the aneurism will produce an increased size of the collateral branches. That the popliteal artery, according to Mr. Pott, is oftener diseased above the aneurism than other arteries, I cannot well determine, but can see no reason why it should be so. If the artery, however, cannot be tied above the aneurism in the operation, where can it be tied if the limb be amputated? *Why not tie it up higher in the sound parts, where it is tied in amputation, and preserve the limb?*

The circumstances to be regarded chiefly turn upon the collateral branches being sufficient to carry on the circulation. The only arteries which admit of this question are the popliteal, femoral, and brachial; the other arteries either having a very free anastomosis, or being out of the way of any operation.

In this account it may be supposed that I carry my notions too far; but it is to be understood that I only give my own feelings upon this subject, and I go no further in theory than I would perform in practice, if patients, being acquainted with the consequences of the disease, would submit to, or rather desire, the operation; nor do I go further than I now think I would have performed on myself were I in the same situation. Not that I would have it supposed that I would recommend this at large: I would have no one perform an operation that he is not clear about the propriety of himself, espe-

cially when it requires more anatomical skill than falls to the share of most practitioners.

Of those Arteries which admit the Operation.—These are, first, the carotids above the sternum; 2d, any of the branches of the external carotids; 3d, the subclavian (after having passed the scaleni muscles), and of course its trunk and branches down the arm; 4th, the crural, immediately after having passed Poupart's ligament, and given off the large muscular artery. How far it would admit of an operation above the giving off of that artery I do not know, but I have seen one instance of that branch and the vessel itself being obliterated by an aneurism, and yet the limb was supplied with blood.

Some of the branches of some of these arteries which I have mentioned will be very difficult of access; therefore, if not in parts that will admit of amputation, the patient will be likely to die. It will be very difficult to take up the anterior and posterior tibial and interosseous arteries, and it will be often necessary to amputate, from the difficulty attending taking them up, besides that the bone will often be diseased before we discover the disease, and this will make amputation necessary.

If an aneurism should take place in the axilla, I should doubt of the propriety of taking up the artery above the clavicle, because I should doubt of its being sound. The same with the femoral artery, where it passes from under Poupart's ligament; unless the aneurism was lower down, and I might expect to find the artery sound.

In dissecting tumours from the neck I have frequently laid bare the carotid artery; now, if by any accident during the operation the artery had been wounded, I should certainly have taken it up with a ligature; or if the tumour had been so engaged with the artery that I could not disengage it, I should have tied it above and below the tumour, with every hope of success.

The operation will be easiest, both to surgeon and patient, while the disease is in its infancy. Although I would perform the operation on all the arteries I have mentioned, and if I laboured under them myself would have them performed on me, yet I would wish every person to judge for himself, and not attempt an operation if he is fearful.

*General Observations on the Operation.**—In performing this

* [It will be observed that the operation Hunter here describes is not the one which goes by his name, but that which was usually practised previously to the general adoption of the Hunterian operation. The first case in which Mr. H. operated according to the latter method occurred in December, 1785, rather more than a twelvemonth before the delivery of this lecture; and he did not as yet feel sufficiently sure of its superiority to the generally received method to recommend it strongly to his pupils for their adoption.]

I gladly avail myself of this opportunity of referring to Mr. Guthrie's able and elaborate exposition of this department of surgery, in his work "*On the Diseases and Injuries of Arteries*," in which the extent and accuracy of Mr. Hunter's labours are set forth with great judgment. The Hunterian operation for aneurism

operation the first attention should be paid to preventing the flowing of blood during its performance, which alone leads to two methods of performing it: 1st, where the tourniquet can be applied; 2dly, where it cannot.

Where the tourniquet can be applied, this should be first done. In the next place make a longitudinal incision in the course of the tumour, of greater extent than the tumour; cut gradually into this, scoop out the coagulated blood, and sponge the inside of the sac; we should then slit up the sac, to discover the openings of the arteries into it. The inferior orifice will be most readily discovered, as it will throw out some little blood of a venous appearance. To discover the superior orifice the tourniquet must be slackened; the artery then should be tied, at least an inch from the sac, at the superior part; but it is not necessary to observe this rule with the inferior part.

When a tourniquet cannot be applied between the heart and aneurism, as in the carotids, an incision is to be made through the integuments; the sac is to be laid bare, but not opened; the artery is to be searched for, and tied above and below on the sound part. The sac is then to be opened, and the coagulum scooped out; and after being cleansed and spunged, the sac may be left to slough, and the wound dressed as other fresh wounds.

The blood which comes from the lower orifice has become dark by stagnation, or slow motion: hence also the dark colour of blood when an artery is wounded below, while the tourniquet is applied, the blood not being venous, as some have thought, but arterial, which has taken a retrograde course. I believe we should not be anxious about the collateral branches; I have lost several advantages from this mistaken delicacy. I believe the circulation will always go on after the femoral artery is secured by ligature.

Cases of Aneurisms.—1st, a young man had for two years a pain in the calf of his leg, similar to cramp; at length he received a blow in the ham, and a swelling, with pulsation, appeared soon after. I gave it as my opinion that the operation should be performed, and if it did not succeed, then to amputate. The operation was performed, and the patient apparently was going on well, till the fifth day, when the ligature giving way, the artery burst above, either from its being tied too tight or too loose. I was now obliged

was not the result of fortuitous discovery, but of accurate and minute knowledge, derived from a laborious investigation of the morbid anatomy of the arteries, and of just reasoning upon the data which he thence derived. The preparations and drawings relating to this subject contained in the museum of the Royal College of Surgeons, convincingly show that Mr. Hunter anticipated the greater number of modern discoveries, at the same time that they evince the indefatigable zeal with which he pursued his researches on professional subjects. By referring to the valuable work above mentioned, I shall save myself and the reader a great deal of trouble in these notes; and I am very happy in having the opportunity of expressing my acknowledgments to the worthy author. I also beg leave to refer the reader to Sir Everard Home's paper on the same subject, and to the remarks in "*the Life.*"

to dilate the wound still higher, and take up the artery higher up; but, apparently from the loss of blood before the tourniquet could be applied, the patient died a day or two after. The leg and thigh were both found to be putrid and emphysematous, and that was the case even above the aneurism. When I saw this man dying from the loss of blood, it struck me as a proper case for transfusion, and if I had been in his situation I would have had the blood of a sheep or hog transfused into my vessels. I do not know exactly how to account for the failure of this operation, whether from the unsoundness of the vessel, or the tightness or the smallness of the ligature; but from the appearance of the limb before the bursting of the artery, and the injection of the vessels after death, all seemed favourable for the operation. The artery also was sound above the part where the first ligature was applied. From these considerations, I should certainly be encouraged to perform the operation again, though this was the case which led Mr. Bromfield to condemn the operation. The second was a case of femoral aneurism in the middle of the thigh, in which the operation was performed by Mr. Bromfield, jun., in presence of Mr. B., sen., after his publication. The tumour was oblong, and extended five or six inches in length, and the operation was performed in a short time, and with success. In the third, where the operation was performed by Mr. Martin for the popliteal aneurism, the patient soon got well, and was able to dance. The fourth was an aneurism in the gluteus muscle. In cases where the arteries in several parts had the disposition to this disease, or, in other words, where many aneurisms were formed, the operation would not be advisable.

In December 1785, I performed the operation at St. George's Hospital, in a case of popliteal aneurism, in a manner different from that ordinarily practised, and with success. The particulars of this case are given in the London Medical Journal. I would only observe, that in future I would advise only tying the artery in one part, and not to endeavour to unite the wound by the first intention. In that case four ligatures were applied upon the artery.

CHAPTER XX.

OF SPECIFIC DISEASES, TUMOURS, HYDATIDS, ETC.

Of Ulcers and the causes which retard their cure.—Abscesses.—Specific diseases.—Irritable and indolent dispositions.—Hypertrophy of parts from chronic inflammation.—Varicose veins.—Corns.—Chilblains.—Of the unnatural growth of parts.—Preternatural accumulations of fat.—Elephantiasis.—Observations on the cure of indolent dispositions.—Tumours.—Encysted tumours.—Tubercles.—Solid tumours.—Warts.—Polypi.—Tumours in the cellular membrane.—The removal of tumours.—Tumours of bones;—their varieties.—Encysted tumours.—Hydatids.—Cuticular tumours.—Of the inflammation of adventitious substances.—Fistulæ.—Fistula lachrymalis.—Fistulæ of the buccal glands.—Fistulæ of Cowper's glands.—Fistula of the parotid gland.—Fistula in ano.—Fistula in perineo.—Cure of Fistulæ.—Of the treatment of contracted joints.—Of tetanus.

I COME now to speak of what I call specific diseases, but before doing so I shall notice the causes which retard the cure of ulcers in sound parts.

These often arise from circumstances not at all connected with the soundness of the parts, as their situation, depth, nearness to tendons, or vicinity with respect to the heart. The situation may make it tedious, though the parts are otherwise strongly disposed to heal, which is often the case in deep-seated abscesses; the nature of the parts may retard the cure, as when abscesses are situated in parts endued with slow or weak living powers, as bones, ligaments, or tendons. In such cases the matter goes a considerable way before it reaches the skin, while the superficial parts are more disposed to heal than the originally diseased deep-seated parts, so that abscesses soon become fistulous.

The cure depends on removing the obstacle of depth by free opening, exposing, as much as the nature of the part will admit of, the bottom of the wound, and preventing the healing up of the superficial parts; but this must not be done unless or until the deep-seated parts are as much disposed to heal as the superficial, so far as respects their natural power, as in cases of exfoliation. Many are slower in healing from the nature of the parts themselves, as bones; but the treatment in such indolent dispositions is very different from that of acquired indolence; for in these there is a disposition to act, whilst in indolence, which is natural, this is wanting. Hence it is dangerous to rouse these parts much, and accordingly we find that the mildest treatment is generally the best, often employing sedatives to lessen the consciousness of danger, as opium, which has often the best effect on parts naturally slow or indolent in disposition, as tendons.

Many sores which go on well at first take on afterwards a

quality contrary to health. All kinds of sores are subject to this change ; but in specific and poisonous ones, the poison must first be destroyed before a good disposition can take place. The causes of this change of disposition are many, but few of them are visible. The most visible is their situation in the body, as in the legs, which are far removed from the heart, and where the healing is prevented by much walking. The slowness often arises from exercise and intemperance, which are first to be attended to in the cure. A horizontal posture, with temperance, should be the first thing advised in sore legs in general, as removing the accidental impediments to healing.

When sores do not heal, after having removed the above causes, some other cause must be remaining, as either an indolent or irritable disposition, or some specific quality, which is frequently to be discovered by experiment. If irritable, sedatives are to be used ; if indolent stimulants ; but if it is not known which of the two exists, first try one, and then the other ; if neither of these is effectual, a variety must be tried till you find that which agrees best. Sometimes one of these does good for some time and then loses its efficacy, the sores becoming stationary, when we must change the application. When sores are indolent in healing, there is a surrounding thickening, but this is seldom the case when healthy granulations arise ; in such compression is proper ; and if walking cannot be avoided, then light bandages, and sometimes a thin plate of lead, which is also often useful when the granulations are loose and there is a disposition to thickening. But these sores are very apt to return, which points out some particular remote cause, which I will presently describe. The sores of poor people are often in a bad condition from bad living, much exercise, or cold, and are often mended by rest, a horizontal position, fresh provisions, and warmth in hospitals, and the change is generally very speedy. If they do not soon improve I always suspect that something more is operating, as irritability or indolence, when I try experimentally different remedies till I pitch on one that is serviceable.

The surface of the sore will easily discover if there is disease beneath, as of the bones or periosteum. If the granulations are broader than the disease underneath, the granulations over the diseased part are unhealthy, whilst those not so are healthy, and heal so that the sore becomes smaller and smaller by the gradual contraction of the granulations.

Sores are often forced, as it were, to cicatrize, but the cuticle is not good, and the part removes it, and removes it again and again, till sometimes at last it becomes a good one ; at other times the cuticle becomes very thick, and irritating the cutis underneath, which is very tender, it is then thrown off like a scab, and leaves the skin underneath ulcerated. These cases must be treated as they were before they were cicatrized ; that is, they must be kept moist, and any cuticle which is unnecessary and thick must be scraped off. The medicines that first healed the sore, combined

with water, should be applied to the sore ; as, when tar agrees, tar-water should be applied.

Abscesses.—In all abscesses we should consider, in the first place, whether their seat is on or in the part at which they appear, for often they are abscesses of parts that are distant from that in which they appear. Thus, the external appearance of lumbar abscess is in the thigh, the loins, or between the ilium and sacrum. Abscesses of the liver also make their appearance externally ; likewise spurious empyema and abscesses of the kidneys, which last often resemble lumbar abscesses, although their seat has been ascertained by the extraction of a urinary calculus. All these generally pass through and between some bands, as tendons, ligaments, or bones, and their first passage is small ; but the abscess, getting into the cellular membrane, spreads, and gives the appearance of a large abscess of that part. None of these, however, penetrate so far as the lumbar abscess, owing to the position of the body, and the disposition of the inflammation having no tendency to set bounds to the spread of the matter.

Treatment.—Little can be done for these cases ; they should be opened slightly or not at all. In the lumbar abscess opening is often productive of hectic fever, much sooner than if left to itself, and consequently death takes place much sooner. But when internal abscesses, whether pointing at a distance from the seat of disease or not, are likely to heal, as those of the liver, they should be opened as freely as possible, in order to know the extent of the disease. If they cannot be traced to the bottom, injections may be used, as they are apt to become indolent. I have used stimulating solutions of caustic, infusion of myrrh, lime-water, and injections of decoction of bark.

OF SPECIFIC DISEASES.

I am now to treat of dispositions and actions which are not productive of restorative actions ; those which we have hitherto treated of, where a salutary disposition is put on, in consequence of violence done to a part, I do not call disease. This is the most complicated part of surgery, as it requires a knowledge of sores and of every local action that can be in a part : it is the physiology of surgery, as a knowledge of the constitution is of medicine. The diseased sores alluded to will admit of being divided into local and local constitutional ; but none are entirely constitutional. The first includes many diseases, as cancer, chancre, mortifications, and many others, which have simply some specific quality. The second, all the poisons and some mortifications. All uncommon actions, commonly called diseases, are divided into common and specific. The common I have treated of. The irritable and indolent may be thought improper to be placed among the following, which are the specific, because either of them may attend all specific diseases ; but almost all uncommon actions are in some

measure specific, all arising from a specific tendency, or susceptibility, brought into action by some leading cause, and therefore not taking on the restorative process as they ought to do.

Every specific disease must have some peculiar action distinct from another. A true specific disease is that which has only one peculiar action. Some have many causes, as gout, yet have only one specific mode of action; others, as the morbid poisons, have only one specific cause. The first is divided into two; regular and irregular. The regular are truly specific, as agues; of the irregular there are many which show disturbed modes of action, as inflammation in scrofulous habits; but these always are very imperfect, from the specific action hindering them from going on properly. These are the opposite to the salutary dispositions for restoration.

Unsound dispositions may be divided into two classes; such as have too much action, and such as have too little action; or better perhaps, into irritable and indolent. The remote causes are many, but the immediate cause may be the same in both: few of the remote causes are known. Irritable and indolent might be classed amongst the common diseases, and not with the specific, as every specific disease may be accompanied with them, and all specific diseases are generally attended with one of them; but some specific diseases are more irritable or indolent than others, and are also different in different constitutions.

Of the Irritable Disposition.—Irritability is that disposition which cannot remain at rest under an injury either in a part or the whole, nor can it set about a restorative action. This depends on some peculiarity both of the nerves and living principle, for there is often much sensibility as well as irritability in a part; or, on the contrary, it may be confined to one only. The one would show that there is an affinity or connexion between these two principles; the other, that this is not absolutely necessary.

Irritability is of various kinds, but generally may be called passive; as even in the most irritable constitution there must be some other disease or some violence to bring this disposition into action. Thus, convulsions, are induced by tickling the skin. Many constitutions are thrown into violent actions from injuries, producing irritable inflammation. But all inflammations are not to be called irritable; those which are exactly sufficient for restoration cannot with propriety be called irritable.

Irritability is most commonly constitutional, but not evidently so altogether, as one part is often irritable, while other parts are not: for example, a lady had a vesication on her shoulder, which all throughout its action gave amazing pain; yet at the same time she had one in the arm which gave very little inconvenience. And we find disease producing irritability in parts which were not irritable before; therefore it cannot be said to be constitutional altogether.

Irritable inflammation most frequently arises from injuries done to an irritable habit. A local disease may produce irritability in a

part, whilst the constitution is not irritable at all; it is then entirely local. But the constitution may be rendered irritable from a local cause, as in bubo. An irritable disposition is generally known by a disposition to inflammation, and that inflammation not terminating in any crisis. It would appear to be a mixture of the suppurative and erysipelatous, at least the erysipelatous seems to attack irritable constitutions most frequently; but probably the erysipelatous attacks when there is weakness, and erysipelatous goes off as in other habits. The effusion and extravasation in irritable inflammation is more watery, so that the swelling is rather œdematous and more diffused; the continued sympathy is very strong, so that it spreads often to a very great extent, and sometimes becomes universal. In many of the irritable inflammations of the skin, excoriation takes place, and the water exudes like a blister. When it is local it is very circumscribed, terminating all at once; in many cases it cannot be distinguished from common inflammation terminating soon, but here the irritability is slight. These often terminate in the indolent, as those arising from cold.

Of the Cure by Resolution.—To cure irritability is extremely difficult, as lessening sensibility is more difficult than exciting parts when indolent. Whilst the parts are only inflamed, we should first avoid every thing which would irritate or hasten suppuration. A cataplasm of bread and milk is the most simple resolute application, and the best till we know how further to proceed. But when from any accident there is too much irritability, something to lessen susceptibility should be used, as opium in the poultice, a fomentation of poppy-heads, or the preparations of lead. However, I think preparations of lead may do harm, as they lessen the restorative power as well as the irritability.

If suppuration takes place, it should be suffered to go on to the true suppuration. Cutting is very disagreeable to these irritable parts, for the irritability still remains, and they will not heal kindly. Caustics are much better adapted for opening abscesses in such constitutions, and should always be preferred, and more especially if opium is joined to them, as either with or without opium they irritate much less than cutting. The matter is generally of a consistence little more viscid than serum. There is often coagulable lymph on the sore, in which case there is little discharge of pus, which is also often the case in the indolent.

The milder the after-dressings are the better; none is preferable to the opium poultice, as they are apt to ulcerate and spread, which opium prevents better than any other dressing. When they begin to have a healing disposition, a mild cerate is preferable to dry lint. Bark internally, as lessening irritability and giving strength to the system, is of considerable service, together with the exhibition of opium; but in some we find a treatment directly opposite necessary, the mildest dressings giving the greatest pain, whilst warm dressings, as oleum terebinthinæ, give agreeable ease, although at first they give great pain in such sores. There is some peculiarity in

the part which is removed by these stimulants; but unfortunately all these fail at other times, and we do not possess a sufficient number for the variety of constitutions we meet with.

Of Indolent Dispositions and Actions.—Local diseases attended with indolence produce generally the following effects, viz., an increase of the parts diseased, which is of three kinds: 1st, increase of growth of the natural parts; 2d, a thickening of the diseased parts; 3dly, an entirely new-formed substance.

The first has no variety; the second is occasioned by adventitious matter extravasated and effused into the cells, which I call interstitial increase, which will produce two different effects: either general swelling, which I call the diffused interstitial; or circumscribed increase, which I call the circumscribed interstitial. But the last has two causes, and is of two kinds; therefore the first owes its figure to the part being circumscribed, the other is from the nature of the disease. The third is always circumscribed, which I call the circumscribed adventitious. They are often spontaneous in their origin.

Indolent dispositions may be either with or without inflammation, and also suppuration; they arise from either a disposition of the constitution or part. This is more rare than the irritable, and is seldom carried so far.

Few constitutions are so quiet as not to call forth their powers when a part has received any injury. But specific affections may sometimes prevent them, and then the common powers have no effect; for in lues and scrofula thickened sores are very frequent.

There may be indolence without any known specific cause; yet I suspect that there must be something specific concealed, which arises from peculiar constitutions in different complaints, as when tumours that are indolent are formed in glands. All constitutions, however indolent, are susceptible of inflammation, and very few diseased parts are exempt from it; yet sometimes indolent sores are not inflamed by the common causes of inflammation, as exposure; sometimes, in the irritable, sloughs are formed, which is a cure by the disease itself. After indolent parts are once inflamed, they are very apt to become indolent again, when the inflammation is removed. When indolence is in a diseased part it cannot be totally constitutional, but sometimes local, as in cancer and scrofula. When this indolence takes place in a part, the cause often steals on gradually, so that the part is not roused by it. Indolence is natural to tendons, ligaments, and bone, and when all these causes coöperate, the disease is worse; but indolence may take place in other parts, from some visible cause, as in muscles, and skin producing thickening.

Many thickenings are owing to specific causes, as the induration of cancer, venereal diseased glands, sometimes affections of gout and rheumatism, and bone is subject to the same disease as in exostosis. Thickenings of parts are either from visible or invisible causes; the first arise from some external inflammation; the second from

some diseased action in the part. The remote cause may be predisposition, climate, or way of life.

Local indolent diseases are generally confined, yet they sometimes spread; but here the cause must be more diffused. They spread but little, because indolence is but a small cause of sympathy; the sympathy is more continued when the sympathizer is of the same indolent disposition as the diseased part. Indolence in local diseases is attended with an increase of the part, sometimes similar to that produced by adhesive inflammation: this effect attends many unnatural actions of parts as well as inflammation. The parts swell more in this disposition than in the others; for in this there is neither any disposition to suppuration or resolution, and therefore there is an increase in the thickening disposition.

The division of this thickening is of three kinds, as before observed. The first is most visible in the adipose membrane; the second, as before; the third, adventitious, and which forms a tumour. The immediate causes are: 1st, a preternatural increase of the part itself: 2dly, interstitial increase; 3dly, the formation of an entirely new part. The first consists in an increase in the figure of a part, as of a gland, a cell, any whole limb, or other whole part; the second is often circumscribed in cellular membrane, appearing to be newly formed; but it is not so, but interstitial, as scirrhus in a glandular or cellular part, which becomes loaded with cancerous coagulable lymph formed by inflammation: the third is an original circumscribed swelling, arising in common cellular membrane, skin, bones, &c., and which should be called true tumour. In some of these diseased parts another disposition or mode of action, viz. ossification, arises; whether from a peculiar disposition arising from this disposition, or to increase the strength of the part, I am uncertain. The first is most probable, as strength is unnecessary where it is generally formed, viz. on the edges, &c. I shall lay it down as an axiom that all thickened parts are to be accounted new-formed parts, although they may be in original parts. The idea of their being all new parts shows why they should be disposed to form calcareous earth.

Thickening, which is generally the first symptom of indolent complaints, often gives little or no pain; so that the sensibility is often not observed till some time after. The thickening gives so little pain as hardly to be communicated to the sensorium: but the heavy dull kind of pain afterwards often becomes very disagreeable, producing sickness, which is more peculiar to some parts than others. The colour is of no particular kind, which shows a languor of the blood in them. The hardness is sometimes so great as to become cartilaginous.

The causes of this thickening are with difficulty assigned. In common inflammations there is increased action, and this is probably the case in indolent inflammation: but this increased action is of a peculiar kind, which may be called indolent inflammation, which is a peculiar mode of inflammation. The immediate causes are

various ; but what the final intention is in most cases is very obvious. In common inflammation it is to form adhesions and limit the disease, but in the indolent it is to give strength.

The visible causes of indolent disposition are various. 1st, The thickening may depend on a diseased part being accustomed to an irritation, till this irritation, losing its power, leaves the part in an indolent state and incapable of recovery. Probably all may be first ranked under the irritable. 2dly, From effects being produced by a disease not indolent in itself, but violent at first, as the gout. 3dly, From a slow alteration in structure taking place, in consequence of gentle irritation, as gentle pressure, which will take place in every part. 4thly, a long application of cold, which produces weakness. 5thly, Peculiarities in climate; as bronchocele in Derbyshire, and swelled legs in Barbadoes. These, and especially the four first, have no connexion with the constitution, yet may be assisted by a constitutional predisposition. They are seldom very diffusive, from their confined sympathy. The first of the first division are most frequent in the lower extremities, these parts being most frequently interrupted in their salutary actions. The second, arising from a disease in itself violent, as the gout, are apt to be very indolent. The third cause is mechanical and very extensive, even universal, and seems to be the consequence of a stimulus, as if increase of strength was wanted, as in the tunica vaginalis, from the increased quantity of water in hydrocele, cysts of hydatids, &c. Veins from this cause become varicose, and the cuticle is often thickened by this in working people; but this is frequently carried too far, and produces corns, or it may produce ulceration if the pressure exists in a still greater degree.

Varicose Veins appear to arise from pressure. A long column of blood presses along the inside of the veins of the lower extremities, and the veins being weak are stimulated, which increases their thickness and strength to resist this distention; sometimes they are so much thickened as to obliterate the whole cavity. The smaller veins are more or less affected, probably in the same manner as the large ones are in the legs, and hence the whole leg is indolent: they often suppurate, when it is almost impossible to heal them. This disease is in general too extensive for extirpation, although when it can be done this practice is very proper.

Corns.—The cuticle admits of being thickened from pressure in all parts of the body: hence we find that on the soles of the feet of those who walk much the cuticle becomes very thick; also on the hands of labouring men. We find this wherever there is pressure, as on the elbow, upper part of the little toe, ball of the great toe, &c. The immediate and first cause of this thickening would appear to be the stimulus of necessity given to the cutis by this pressure, the effect of which is an increase of the cuticle to defend the cutis underneath. Not only the cuticle thickens, but the parts underneath, and a sacculus is often formed at the root of the great toe, between the cutis and ligaments of the joints, arising from the same cause,

to guard the ligaments below. Sometimes, when the pressure is uncommonly great, inflammation takes place in this part, especially if there are corns, the sacculus suppurates and opens externally, and this forms what I believe is called a bunion. The sacculus then closes again, and leaves the parts much as they were before.

The cuticle is not only thickened from pressure for salutary purposes, but it is also carried to disease. A corn is a thickened cuticle arising from external pressure, which is preternatural and continued. Uncommon or preternatural pressure on the surface must always affect the cutis more or less, producing a disposition in it to guard itself; but pressure is capable of producing another effect, which is according to the amount of pressure: when applied in a moderate degree, it gives a disposition to the cutis to continue the growth of the cuticle, forming layer upon layer. By this continuation of growth the cuticle becomes thicker; but if the pressure is too violent, then a diseased increase of the cuticle takes place, commonly in a very small portion of the part pressed, often in a point. This thickened part being pressed from without commonly sinks its own thickness into the cutis, which is the cause of the pain and troublesome symptoms. The cuticle being formed in layers peels off in layers, and if inflammation attacks the cutis underneath, this takes place: and hence the term 'onion,' which has been applied to these corns.

There is often a sort of joint formed by a sacculus mucosus under the cutis allowing of motion in the corn: if this inflames and suppurates, a cure is often effected.

When corns are of long standing and run pretty deep, they generally produce a degree of indolence in the healthy actions of the parts pressed on, which makes the cure tedious.

The cure of corns is of three kinds, viz. natural, palliative, and radical. The first is by removing the primary cause, or pressure, which is done by leaving off shoes, or by introducing a soft substance, as plaster, between the corn and shoe. Two plasters are necessary, one with a hole opposite the corn, and another to be applied over this; and these should be continued as long as the cause is continued. Leaving off the pressure is the best mode, and then the effects are easily removed. The palliative consists in removing as much as possible the external surface, which relieves the pressure. This is done by holding the corn half an hour in warm water, when it swells, and then paring off as much as possible of it. It is difficult to remove the whole without injuring the surrounding cutis, which is often of bad consequence in old people, where fatal inflammation and mortification have been caused by it. The radical cure consists in removing the whole corn or thickened cutis. The cuticle may be raised here, as it is in every other part, by blisters: but its thickness prevents this effect taking place so early. Warm stimulating plasters will in general be sufficient. The causes of corns when carried too far often produce inflammation and suppuration, and whichever way the suppuration is pro-

duced, it is liable, if not attended to, to become very tedious; for the skin having a greater disposition to heal than the parts underneath, produces a fistula; so that such sores should be dressed to the bottom, and if they are indolent at the bottom should be stimulated by appropriate dressings.

Indolence from Cold.—Cold is a powerful obstructor of the natural animal powers, whilst at the same time it is exciting action, producing irritable inflammation and death. It is a true cause of mortification. Indolent swellings from cold arise from two different modes of action: 1st, when so gradually applied as not to excite irritable inflammation, but a gradual sluggishness; 2d, when it produces irritable inflammation from the parts being weakened. Cold does not immediately obstruct the natural actions of the whole or part, but excites the whole or part to another action, viz. the production of heat. The extremities, from their great distance from the seat of the living power, and from being smaller, are most liable to this. Thus these parts become first irritable and then inflamed; but it is an increased disposition to act, with lessened powers. Hence the effects of cold are greater or less, according to the constitution. The weakly, the fair, and the delicate have the least power of generating heat.

Chilblains are the common effects of these causes, and from the foregoing effects of cold we are led to a rational cure; first, to remove the cause, then to apply warmth, or rather to keep the parts temperate. Chilblains commonly get well in summer. The cure, perhaps, should be divided according to the two stages of the disease, viz. the irritable and indolent; but how far the treatment should correspond in this way I cannot say. They have been cured when they looked purple and livid by gentle stimulants, as oleum terebinthinæ, or camphorated spirits of wine. Such applications bring on the florid red of inflammation, which generally terminates well, for they seem to counteract the stimulus or irritation of cold. Steeping the parts in warm vinegar has done much good; when they ulcerate, the same exciting mode seems best. But they are sometimes so irritable as to require quieting; for which purpose a poultice or decoction of poppyheads is equal to anything. When the itching begins, rubbing the feet over with powdered chalk will be effectual to prevent it: the rubbing is useful, and the chalk keeps the feet warm by being a bad conductor of heat.

The invisible causes of indolent dispositions are also various. The 1st of the spontaneous is a diseased increase of growth; 2d, interstitial swelling; 3d, new formed substance. This division, according to the mode of increase, is into three kinds, viz. increase of natural parts, the interstitial, and the tumour. All these are liable to happen in every part of the body. These increases are either known by the sight or by the feel.

Of the unnatural Growth of Parts.—These often form what may be called a species of monstrosity of parts, either diffused or circumscribed. They are generally situated in the cellular membrane,

and feel doughy and soft, and are usually superficial, extending to the skin till it hangs as if by its own weight, sometimes having a broad base, but often hanging by a small neck: they appear to be in the cellular membrane what exostosis is in bone. These parts are less ductile than the natural parts. I have seen the double chin become one of these; I have seen them on the belly. Perhaps they produce absorption in the parts on which they press; for the bones underneath have been sometimes found deficient.

Preternatural accumulations of fat take place in the same manner; not depending on a deposit of interstitial substance, nor being adventitious, but a preternatural growth; and are common to every part of the body, not excepting the internal parts. People have died of fat on the pericardium, and sometimes it is found in the bellies of cattle, as sheep. In the human subject these accumulations acquire an immense size, being composed of very solid fat, and in some degree moveable, being in separate parts, or lobulated, when between the skin and muscles. They may in general be distinguished by the former being of a regular uniform softness, whilst the latter appeared to be composed of solid pieces of fat, having a surface irregular to the feel.

The interstitial or diffused thickening of a part arises from the interstitial deposition of matter in the cells of the part, and is of three kinds.

Elephantiasis.—The first, or diffused, is very slow in increase, forming gradually. A whole leg will become stiff and feel tight by a loaded cellular membrane. It is most frequent in the legs, and almost peculiar to some countries and to some peculiar constitutions. A similar increase occurs in the thyroid gland: but this is of the second kind. The diffused is very common in the legs of Barbadoes' people; I have also seen it in this country, but very rarely. The legs of young people I have seen so swelled as to be all of a size. It arises from an extravasation of coagulable lymph equally diffused; the parts become firm and similar to dropsy, only there is no pitting: it may be a kind of dropsy, for dropsical swellings often degenerate into this kind of swelling; yet the cause of the two may be very dissimilar: it is most frequent in young people. From its being so diffused and general, and in the legs, and most at the lower parts, I should think one of its immediate causes was a depending situation, with a weakened action of the system in general, as a simple bandage to support these parts often prevents it. [*A preparation was shown in which a thickening of the leg put on the appearance of brawn.*] There is no fixed cure. In the case I saw I recommended mercurial ointment to be rubbed into the parts, and a slight bandage. The ointment was omitted; but the patient got perfectly well in a few months. If these had failed, I should have sent him to bathe in the sea. Pressure hinders the extravasation of more fluid, and we see that tight boots make the legs thinner.

The second kind is an original disease, though it may be attended with pain and inflammation. It is not circumscribed, though con-

fined to a spot, but gradually lost in the surrounding parts. It spreads in proportion to the power of continued sympathy. A node is similar in appearance to what this is of the soft parts, and perhaps is of the same kind.

The pain of indolent swellings is very little or none at first, which is owing to the slow increase of the part not arousing the sensibility; but afterwards they have a heavy dull pain, producing sickness. This is often from the size, as well as from the tumour itself pressing on some other parts; for sometimes there is more pain in the surrounding parts than in the tumour itself. I may also observe that they seldom or ever inflame, but continue increasing till they press on surrounding parts, and raise inflammation in these parts and not in themselves; they are then often broken down into a curdly substance, but appear not to be dead, as they do not give the stimulus of extraneous matter: though the surrounding parts become thickened, yet they cannot properly be called encysted. If it appears to be scrofulous, the cicuta, sea-bathing, sal sodæ, sea-water poultices, &c., are to be tried; but these are sometimes useless, and extirpation becomes necessary; or sometimes cutting into them is sufficient. They sometimes suppurate, and then the sores are very difficult to heal.

The third kind consists in the interstitial increase of a circumscribed part. This is it when the swelling keeps to the original part, that part being circumscribed, as lymphatic glands, and also tumours or enlargements of the liver or spleen. They seldom affect the cellular membrane till they suppurate, and often not then at first, which shows they have something specific in them; for if merely indolent the surrounding parts would sympathize with them, as is often the case in the mixed cases. Although these diseases are interstitial increases, yet they often become similar to a tumour, and are understood as such.

Observations on the Cure of Indolent Dispositions in Diseases.—We must first inquire whether they are wholly constitutional, partially so, or merely local, as upon this rests our treatment. We must not be satisfied with the present symptoms, but inquire into the constitution, whether it is indolent or irritable. Such as arise from the constitution are generally more diffused, and are often in many parts: and such constitutions as produce local complaints show something wrong in them; however, the symptoms are not always satisfactory. I suspect these indolent dispositions of the constitution require a specific stimulus, having something specific in their nature. They do not spontaneously take on steps of cure, as inflammation does; and if they suppurate, they do not suppurate kindly; and a variety of things are required to assist them. The first thing to be done is to remove the cause, if practicable, which it often is not, as changing the country and situation. In all, resolution should be preferred if possible, by absorption; for suppuration will do much harm. To procure suppuration in such, a particular mode is required, for we are not to lessen the living

powers, as in adhesive inflammation that is healthy, but to increase them. The earlier the treatment is pursued the better, before the habit has suffered, or the surrounding parts have sympathized: sometimes a constant application of mercury to the part, which produces a kind of irritation short of inflammation, is advantageous; if this is insufficient, fumigations with cinnabar, or with plants which have essential oil in them, may prove serviceable. If these fail, we must remove the indolent disposition by exciting an action which they are incapable of taking on themselves. Salutary inflammation in surrounding parts will produce other good effects in indolent diseases, for indolence arises from a want of predisposition to healthy action; thus, blistering the parts, and giving cordials internally, are often of use; but the more violent the inflammation, the more effectually is the indolence of the part removed, if it can bear it. Many indolent swellings are content with their own natural actions, as natural parts are with theirs: but this is not so always; but they take on an inflammatory action, not salutary, but leading to a bad kind of suppuration. The means of restoring the thickened parts is healthy inflammation, which as it goes off, does not leave them in their former state, but occasions an absorption of the extravasated matter; nevertheless the part, after healing, often retains somewhat of the original disposition. This treatment will not do either in cancer or scrofula.

Of the Suppuration of Indolent Parts.—Resolution cannot always be effected, and suppuration will take place, which suppuration seems to arise from defective animal powers, and not from exerted powers. The matter is glairy, and the superficial parts are so little susceptible of this that the matter is long in coming to the skin; so that stimulating medicines must be applied to bring on, if possible, good suppuration, which can seldom, however, be done. Quick ulceration is best effected by exciting and hastening the inflammation; this is necessary in sound abscesses even, but much more necessary in indolent ones. The next thing is opening them, which should not be done too early, as the matter which remains in may increase the inflammation, which is necessary to the cure. When an opening is made it should be as large as possible; and even crucial incisions are frequently necessary; in many cases scarifying the sides of the abscess is proper, to excite quick inflammation, and if there are any sinuses these should be traced to their full extent: the parts then feel a greater necessity of action. But this is not always sufficient, for after good granulations are formed, the indolent state often returns, the granulations becoming dark-coloured, and the matter thin and glairy, according to the specific nature of the indolence; this is the case often in old sores which have become habitual from bad treatment. In old indolent parts and encysted tumours the sac is often thickened, and even ossified, and the inflammation then is sometimes so violent as to threaten mortification. But these parts often become insensible to the common causes of inflammation, and when inflammation does arise it is sluggish. In such, nothing can

cure but dissecting out the parts. Many abscesses, if out of the reach of surgery, or ill-treated, run into an indolent state. Many means are necessary in treating them, but we know of few useful ones: balsams and warm dressings are commonly used; sometimes they do good, at other times they have no effect; and when they agree they lose their powers by continuance, when it becomes necessary to change them, or increase their power. These balsams should often be mixed with red precipitate. Tincture of myrrh also is often very useful in indolent sores, requiring to be applied often, as it soon loses its efficacy; solutions of alum, tincture of bark, solution of lunar caustic, aqua camphorata, &c., are often useful, and require to be applied as often as three times a day, or oftener if the disease is considerable.

OF TUMOURS.

By this term is generally understood a circumscribed enlargement in a part from disease, not strictly a disease of a natural circumscribed part, as a thickened diseased gland.

Of circumscribed interstitial enlargements in common parts.—These seem to depend on an accumulation of extravasated coagulable lymph, either in the adipose or cellular membrane, or both. They are of two kinds; one is probably scrofulous, and not so circumscribed as the other. The wen is commonly found in the cellular membrane of every part, but how formed it is difficult to explain; perhaps there is an absorption of the natural original parts underneath. The increase of cancer is much in the same way; a good deal of the cancerous matter appears to mix with the natural parts; but these natural parts appear to be lost as the cancerous matter increases. The specific quality of wens is not yet known.* They retain their living properties, and sometimes swell to an enormous size; sometimes they remain stationary, and sometimes they become solid throughout, so as even to be as hard as cartilage; when cut into they look like a lemon, but not so regular; they seem to have no leading cause, constitutional or local. Calcareous earth is often deposited in them. The first mode of preventing them, if we

* [Sir Astley Cooper has described a species of encysted tumour or wen of the common integuments, which evidently depends on an obstruction of the follicular ducts of the skin, in consequence of which the sebaceous follicles become distended by the accumulation of morbid secretion. Ranula, and the enlargement of the labial glands, are analogous cases, and it is extremely probable that many other forms of tumour, such, for instance, as the serous cysts which are developed in the viscera, and the solid tubercles which occur in similar situations, owe their origin to a like cause, that is, to an obstruction in the primary branches of the excretory ducts. In general, however, the origin of adventitious growths, (see note, p. 150,) and the distinction of their specific natures, is involved in much obscurity, so that every attempt which has yet been made to classify them according to their natures has failed. The truth of this observation respecting the classification of tumours has been generally felt, and will be perceived in the ensuing observations of the author.]

had any, would be by resolution, both by topical and internal applications; but we have none of much power in this respect. For those which are external, as in the cellular membrane, such remedies as were recommended in the diffused are proper; but these are more difficultly removed than the diffused, and, being circumscribed, are less capable of sympathy, and more indolent; perhaps mercury is the best resolvent for them; electricity is not so much to be depended on as mercury; suppuration of them, by cutting, or any other mode, will do no good. They produce a sore which it is impossible to heal, and which often becomes cancerous; therefore suppuration should be avoided, as it diffuses the cancerous disposition. Extirpation is the only remedy, so that the earlier this is acceded to the better. Their situation makes caution necessary, in the avoiding to wound surrounding parts. I have laid bare the carotid in the necks of women, also the temporals for two inches, and often have laid the trachea bare. By care and attention these operations are very easy and safe. The jugular vein I have also laid bare; but I would tie its two ends, as it is afterwards very apt to slough.

Tubercles may be classed under the head of spurious tumours: they are most frequent in the viscera. They are mostly of the lymphatic kind, and are often formed in the lungs of young people, and sometimes grow to a considerable size: they are often on and in the liver, the spleen, the uterus, the coats of the intestines, the peritoneum, and sometimes on the epiploon: the lungs are frequently full of them, and they are the cause of most consumptions. How they are formed, and whether glandular or not, I cannot determine; but I think they arise from scrofulous dispositions taking place in the lungs: their texture is often smooth.

Solid Tumours.—Tumours may be divided into solid and encysted, which are very different diseases. Solid tumours differ from wens in being an entirely new-formed substance, and of new structure. Their situations are three: 1st, on the skin, forming warts, which are also sometimes seen on the mouth, lips, and œsophagus; 2d, in the inside of membranes, or canals, which are termed polypi; 3d, in the cellular membrane of every part of the body. They commonly arise from one fixed point, as a root, and then spread out in all directions, if the surrounding parts allow of it. These tumours, formed in solid substances, are perfectly circumscribed; they are generally more detached from the cellular membrane than the lymphatic glands.

1st. *Warts* are external or superficial: they also form on the inside of the lips, beginning of the vagina, and prepuce. Warts differ, according as the cutis and the cuticle differ, in different parts: when these parts are firm, the warts are hard, as on the hands; but if soft, the warts are soft, as on the mouth or lips. They appear to arise from the true skin of the parts, and generally arise from, and are fixed on, a small extent of surface, projecting considerably, so as sometimes to be even pendulous, with a narrow neck. In hard

parts they arise only to a small height, and appear to split into many parts, and often by accident become painful, bleed, and inflame. Those on the penis sometimes have a broad basis, and rise not so high, and divide into points. On the inside of the labia pudendi they often grow very large. It is difficult to assign their cause, but sometimes we see an immediate cause, as the venereal disease in the genitals.

2d. *Polypi* arise on the canals, or passages, each of which seems to produce a kind peculiar to itself, as the nose, vagina, uterus, &c.*; they are supposed also to arise in the urethra, and I have seen them in the rectum in men. They have generally small necks, and require extirpation; those from the Schneiderean membrane are generally in a cluster, numbers arising from the same root; internally they consist of a reticular membrane, whose interstices are filled with a watery fluid, and, besides this, an external covering, both of which coats are vascular, but more particularly the external. They are inconvenient according to their size, often causing a tickling in the nose, which excites sneezing; when large, they are evident to the eye, either externally or internally, appearing to be semitransparent bodies within the nostrils; but when protruded so low as to be exposed to the air, they become opaque, &c., and are then sometimes supposed to be cancerous; and, indeed, we should be cautious in extirpating them, as cancerous tumours are sometimes found in the nose. The best mode of removing them is with a forceps, but seldom more than one can be removed at the same time. If the polypus is forward, it must be extracted anteriorly by the nostril, the patient blowing the nostril as much as possible, to bring it forward. When the operation is simple, it is merely necessary to twist it off by a rotatory motion of the forceps.

3d. *Of the third species.*—This is an entirely new substance in the cellular membrane, often irregular, attached by loose cellular membrane to the surrounding parts; we have also often such in bones which have been diseased: they seem to occasion the absorption of natural parts. Pressure often hinders their growth, and sometimes even occasions their removal by absorption; but this is not always efficacious, and then extirpation is the only remedy. When in soft parts, we use the *knife*, and each incision may go as close to the tumour as possible, the surrounding parts not at all sympathizing; but if there is a root, then a little deeper: if the root goes to the surface of the bone, we cauterize it. On the bone,

* [It is questioned by some pathologists whether polypi, analogous to those which arise from other mucous membranes, are ever found in the uterus; at all events, those tumours which are usually called polypi of the uterus are ascertained to be of a different kind. These latter are in fact precisely similar in structure to the fibrous or fleshy tubercles so frequently found imbedded in the tissue of that organ, which vary in their appearance according to their situation, which allows them sometimes to assume the pedunculated form. This I think is rendered quite certain, from the fact that they occur on the outside of the uterus as well as on the inside, and in that case hang into the cavity of the pelvis, just as in other cases they do into the cavity of the uterus.]

pressure will keep them down, or even make them lower than the common surface of the surrounding bone. Tumours often arise and shoot out from the alveolar processes, and the alveolar process often takes on the ossific disposition along with them: sometimes, but not always, they have bony matter in them.

On the Removal of Tumours.—We should first consider the kind of tumour and part; if a simple body, the knife is the best mode of removing it. The first difficulty in the mode of opening it is, at first setting out, to know whether one or two incisions should be made in the skin. One incision is often sufficient, and two are often necessary; one is sufficient where the tumour is small, or very loosely attached to surrounding parts; but two are necessary when the tumour is large, or where the skin is diseased over it, so as to confine it much, even if small, as on the head, or sole of the foot. A simple incision is sufficient in fatty tumours, except when very large. In the dissection of common tumours we need not be at all nice about the tumour, nor in removing any of the surrounding parts; but in scirrhus, or cancer, the incision must be extended to surrounding parts, and this is not for convenience, but for the success of the operation.

For these wounds there are two modes of treatment; some heal by the first intention, others by suppuration. The first, when the skin will cover the whole sore, bringing the ligatures out at the under angle, when any are required to secure the vessels; but when the sides cannot be brought perfectly in contact, or when sloughing is expected, suppuration must take place; but in many such cases some part may still be healed by the first intention.

Of Tumours in Bones.—Besides ossific inflammation, as before mentioned, we have sometimes tumours, arising from extravasation of blood or scrofulous inflammation.

1st. Those from extravasated blood appear sometimes to arise from the surface of the bone, or else from its substance. The bone becomes lost in proportion to the size of the tumour; which arises from an unnatural accumulation of matter pressing on the part, occasioning absorption: this is most remarkable when the tumour is on the inside of the bone, which then appears as if scooped out; and as the cavity enlarges by absorption, the body is in proportion accumulated. This kind of tumour, arising from disease, differs from that arising from accident, as from fractures, these not exciting ossific inflammation in the surrounding parts; except, indeed, when in the leg and thigh, where, strength and support being needed, Nature forms new bone to supply the deficiency of the old. I can hardly tell whether the extravasation of blood is a cause or effect. Bones will break from this kind of tumour by very slight causes, such as by turning in bed; for before the whole cavity of the bone is absorbed, the bone generally gives way, and is fractured by a very slight cause: after the bone gives way, the extravasation increases from the continued disease and new-ruptured vessels. This kind of fracture happened to the Archbishop of Canterbury.

Mr. Grindle has many examples of this in different bones in his possession.

2d. The second of these diseases in the bone which have the same appearance, is an accumulation of curdly substance; probably it is coagulable lymph, and may be reckoned among the encysted tumours. The ossific inflammation often goes on here, till the bone acquires great size, but in these the outer ossific accumulation is not in proportion to the absorption, and therefore, being only a thin shell, it gives way; this is most common in the head of the tibia, and is called *spina ventosa*. Scrofula, attacking bones, makes them soft, and also thick, although their structure often remains; however, sometimes it is altered, scrofulous matter being deposited, and then the natural matter is removed, till at length all the matter which forms the bone becomes scrofulous. Such cases in a bone generally increase so much as to approach the skin, which inflames, ulcerates, and exposes the parts; and this increases the internal disease, which neither nature nor art can possibly cure; and then a hectic, sooner or later, according to the habit of the patient, seizes and destroys him. These two different causes, perhaps, have some connexion, yet the last is most scrofulous. In the treatment, we ought first to prevent the extravasation, &c.; but we neither know the disease, nor how to effect this intention. If known early, perhaps exposure and sea-bathing would be the best cure.

3d. These tumours are of two kinds: 1st, tumours simply, which are often scrofulous to appearance; 2d, the cancerous, which at present I defer. The first kind I have often seen, and most frequently in the lower jaw, and upper part of the tibia. The latter is probably a species of *spina ventosa*. If the disease seems to be true scrofula, then sea-bathing may cure it, but this is more difficultly known than in soft parts. When of the soft kind and convenient, pressure should be tried, which often is of great service, as in Mr. Squire's case; but when this fails, electricity, or the mercurial ointment and camphor should be used; and when this also fails, an operation often becomes necessary; an incision should be made upon it, and it should then be dissected out as in scalping, as close to its root as possible, with a little of the surrounding parts with it. If from bone, it is impossible to remove any of it by the knife, and it becomes necessary to cauterize it. Sometimes a saw or pincers are necessary for its removal, and cauterization of the cavity afterwards.

Encysted Tumours.—These commonly consist of a bag, or cyst, filled with a substance softer and different from the surrounding parts, though not necessarily so. The cysts are of two kinds, viz., natural and acquired. Natural, as the tunica vaginalis containing a fluid morbid in quality or quantity; Fallopian tubes; the uterus or oviducts of animals; when, for instance, their fœtus or eggs are preternaturally retained; these parts then taking on the nature of the coat of an encysted tumour. Sometimes they arise from an

obstruction of the duct of some gland, which forms a tumour: I have seen them on the inside of the lip from this cause. The second, or acquired, are in consequence of disease in solid parts, and have much the feel of common tumours. It might be supposed they were common tumours suppurated; but they are original specific diseases. They contain varieties of matter; and hence they are divisible into several kinds: as, 1st, hydatid, from their contents being watery; 2d, various matters of different consistency; 3d, a curdly substance. The thickened cellular membrane, condensed by pressure, forms the coats of the first and second; but I know not how the third coat is formed: some of them probably are scrofulous: and if so they are no more than very indolent abscesses in those parts, having acquired a strong coat, which I think is sometimes the case.

1st. Hydatids vary in kind, from the variety of their situation. All accumulations of water in cavities, are properly hydatids. (See *note*, p. 229.) The water may either be in a natural cyst, as the tunica vaginalis, pericardium, &c., or in a cyst formed by disease. This second division is of two kinds, but both occur in the cellular membrane. The first is filled with serum, and therefore similar to the above; the second is lined with a peculiar substance. Those of the first kind are most frequent in those parts which have an enveloping membrane, as the abdomen and thorax; and are more common to some of these than to others, though it does not arise from their having a cavity, but from a peculiar disposition of these parts; these hydatids project into the cavity. Those in the cellular membrane are very uncertain in their situation. The first kind, or simply watery, are often in women's necks, or in the thyroid gland. I once saw a large cluster in the neck of a woman. As they increase in size their coats increase in thickness: those in the cellular membrane thicken soonest: for the lining membranes, or cysts, only thicken by a species of adhesive inflammation. The second differ from the former, and are made up of two parts: the strong external coat is lined by another, of a dusky white colour, much like the retina of the eye, and gelatinous; this coat is generally as thick as thin pasteboard, and as strong as thick wet paper. In many hydatids there is an additional or third coat on the inside of this, which is less opaque; and sometimes a fourth, and so on, till at last nothing is seen but coats; none of which, except the external one, is vascular. It is easy to account for the formation of the external coat; but difficult for the internal ones. Whether the external is the first, and the parent of the others, or the consequence, is not easily determined; but the last is most probably the case, as when formed, they stimulate so as to produce a vascular coat; but whichever is formed first, we must suppose that it is capable of continuance. I suppose the first formed is the nucleus, and so on; similar to a nest of pill-boxes, one within another. There is another somewhat similar, but more irregular; the external vascular coat being full of small ones, as shown in

this preparation [*exhibiting it*]. Does this last species proceed from indolence? Many animals die of them in the liver, in cold climates, especially sheep: it is in them called the rot. Hydatids cause little sensation, and are seldom known till of a considerable size.

Hydatids of the Uterus.—Those of the uterus and ovaries are generally circumscribed bags,* and generally are numerous, especially in the ovaries, and appear somewhat similar to those of the scrotum; forming a species of hydrocele of the part. At first they are thin, containing a transparent fluid; but afterwards they become thicker, and the fluid is bloody, or like a jelly. They have when small but little attachment, but afterwards get to adhere to each other, when they grow often very large, and increase the size of the belly, forming ovarian dropsy. The history and progress only of the case can in general distinguish it from ascites; at first there is a partial, moveable swelling, rolling from side to side in bed. Afterwards they become fixed, but even then, in thin people, inequalities may be felt; when large, they become fixed to the parietes of the abdomen; and if the person is not very fat, a fluctuation may be felt. The health is but little affected by them. Hence the cause is very different from ascites, where the health is first injured. Tapping is only a palliative cure, and a large trocar is required, as the fluid is generally gelatinous, and then only one cell is opened. If taken in the incipient stage, they might be taken out, as they generally render life disagreeable for a year or two, and kill in the end. There is no reason why women should not bear spaying as well as other animals; it would be simply opening the cavity of the abdomen, which we often do without inconvenience in healthy constitutions.†

Hydatids in the Kidneys.—They are of the first species, of the adventitious, and are generally situated between the first and second laminæ of the external coat; but they are certainly often in the internal substance of the kidney. Sometimes there are a great number. Those in the coats are never detached or pendulous; the

* [The hydatid which forms in the uterus is peculiar to that organ, at least in the generality of cases, being of a pedunculated form, and generally grouped together like a bunch of grapes. Hydatids in this situation often attain a great size in the aggregate, and are expelled by a parturient effort. There is reason for suspecting that this form of hydatids most frequently arises from impregnation, in which case the destruction of the ovum is almost universally the consequence.]

† [This recommendation has been adopted in several cases, but the success has not been found to warrant its repetition. The difficulty of ascertaining whether one or both ovaries is affected, as well as the obscurity in which the disease is involved in its earliest stages, are insurmountable objections to the operation; for I do not suppose that any one would be so bold as to propose it after the cyst has attained any considerable magnitude. Besides, it sometimes happens that the disease remains stationary for many years; and in other cases a cure is effected by the suppuration of the cyst consequent on tapping, the danger of which is scarcely greater than that which would attend the operation of extirpation.]

coats are thin, and look like a red grape; they give no symptoms of any kind, nor do they require or admit of any remedy. Sometimes those about the kidneys burst into its pelvis, and come away by the urethra. A gentleman had a considerable swelling on the left side of his belly which had been a long time collecting, and evidently contained a fluid; on a sudden a considerable quantity of fluid was discharged from the bladder through the urethra, and along with it a large number of hydatids; some whole, others burst; but the swelling of his abdomen subsided and he got well: however, he afterwards filled again; but he again emptied them by the ureters, and he is now perfectly well.

Hydatids of the Liver.—The liver may be said to have none but those of the second species of the adventitious; they are generally, but not always, on the exterior substance of this viscus. In some rare cases they have produced ascites by their coats bursting internally; and sometimes they have been discharged externally by their coats adhering to the peritoneum, and inflammation and suppuration coming on. When known to be a bag containing fluid it may be opened, but I would not be in a hurry to do this.

Hydatids of the Lungs.—These are of two kinds: first, a collection of water simply in one or more cells; the second, of the adventitious kind, either external to, or in the substance of, the lungs. Some open into the trachea, and are coughed up in abundance; sometimes they produce spurious empyema, when they should be opened pretty early, to prevent their affecting the substance of the lungs by pressure.

Hydatids of the Brain.—These I have never seen increase so far as to cause inconvenience. In some animals they are common when young, and are successfully taken out. They are very frequent in the plexus choroides.

Hydatids of the Thyroid Gland.—Sometimes these are very large, and produce difficult respiration and deglutition.

Hydatids of the Cellular Membrane.—These are generally of the first species of the second division of the adventitious, containing a transparent fluid. Some parts, and more especially women's necks, are more subject to them than others. They are also pretty common on the inside of the lips of men.

2d. The second kind of encysted tumour contains matter of various kinds, and are very similar to hydatids, often containing in part a watery fluid. In the ovaries, fatty, cuticular, and hairy tumours are sometimes formed.

The treatment for the two first is the same. From their situation we may divide their cure into two kinds; one admitting of external applications, the other not; but I know no medicine which will cause their absorption. When external, therefore, the only means is opening them, when they will inflame, suppurate, and may be managed as in common hydrocele; but so much nicety is not here required, as the sac, being generally thick, will not collapse. In some a free opening is only necessary; sometimes they inflame

spontaneously, but rarely, and even then a free opening is necessary, on account of their indolence. If the sac is much thickened, the exposure by opening will generally kill it, and cause sloughing; yet exposure is not always sufficient, but the whole sac will require dissecting out, and especially when we consider that there is sometimes in these a cancerous disposition.

*Of the Cuticular.**—The adhering cellular membrane forming the sac, takes on the disposition of the cutis, or more properly is changed into cutis, and is capable of generating an external one when exposed; it is lined, indeed, with a cuticle. These cysts often have so much the disposition of the external part, as to have hair grow in them, which is the same as that which covers the animal, as, for instance, wool in the case of sheep. Every part of the body is subject to them, but some parts particularly so. The ovum is subject to all kinds of encysted tumours, and to these more than other parts; and they probably throw off the cuticle every year, or oftener, the cuticle being filled with hair. They are also filled with various matters; sometimes with a caseous substance, in others with oil, fat, bones, &c.: they occur also in the eyelids, in the skin near the eyes, and in the lips, and all grow to a large size.

There are two methods of cure, one dissecting out the tumour, the other opening it freely, or taking off the projecting part and leaving the basis: on the eyelids, when very superficial, they often burst, matter is discharged, and they get well. On the head they are opened and get well. I have seen the external skin only taken off, which gave rise to an inflammation round its edge, which suppurated and granulated, and healed over, producing a cure.

A gentleman had a large encysted tumour on the muscles of the abdomen; this was opened by taking out a circular piece of the integuments, comprising the fore part of the sac. The wound of the integuments suppurated; but the internal surface of the sac, which was now fully exposed, never suppurated the least, so that the wounds of the integuments granulated and healed, tucking down the integuments to the thin surface of the sac. The patient has remained well ever since; but has a large cicatrix, part of which is composed of what was the internal surface of the sac. The surface of the internal coats of these tumours has a skin somewhat like that which covers the glans penis, different in some respects from that with which the rest of the body is furnished, but not of such a nature as to suppurate on exposure.

3d. Encysted tumours, in a part depending on an indolent disposition or suppuration are commonly deep-seated, and their progress is very slow at first; they appear as an abscess, and might

* [The reader is referred to Cooper and Travers's "Surgical Essays," p. 215, for an account of encysted tumours forming on the scalp and face. These strictly come under the designation cuticular, and have been adverted to in a previous note, p. 330.]

be suspected to be encysted, from their giving no pain. I have seen sometimes a chain of them leading from the skin; that nearest the skin appeared to be the original of them. These often deceive the surgeon, who is either satisfied by opening or dissecting them out, suspecting no more of them; and I know no characteristic mark of their presence when the original one is deep-seated; when external, the examination after the removal of the first may distinguish them.

Of the Inflammation, Suppuration, and Ulceration of new-formed parts or substances.—We shall find these parts more liable to dissolve than the natural parts are, having weaker powers of action. In proportion, therefore, to the quantity of new matter, is the part weaker; and these parts go through their diseases much quicker than original ones. When new-formed parts are under the necessity of inflammation, a very slight cause is sufficient; and the inflammation goes on more rapidly than in original ones; and it requires more attention and care to stop its progress. They are both more ready to mortify and suppurate. If in the adipose membrane or skin, and the inflammation is beyond resolution, then no suppuration, but ulceration, takes place, and mortification rapidly ensues; but it will be confined to the new-formed part, except in very bad constitutions. When suppuration has taken place, or mortification, there must be also ulceration, which is very rapid; so that an abscess in parts where an abscess had been before, will be much quicker than before in pointing, or than in other sound parts: if mortification takes place, the separation will be almost immediate. Hence it appears that it is a deposit of matter originally from the constitution, and she lays a claim to it in removing it and repairing it again at pleasure. Simple fractures sometimes disunite, though stronger than by granulations: in these cases no inflammation is produced, at least not so much as to produce suppuration. Union of parts by granulations often disunite, both in soft and hard parts, hence old sores and old fractures disunite. This disposition of fractures to disunite is most frequent in the lower extremities; the substance appears to be shorter lived than the original part was, as in old sores, which so frequently break out again. In parts united by simple extravasation, and adhesive inflammation, which again ulcerate, there is no suppurative inflammation, but there will be in parts united by granulations and suppurations. Ulceration, though frequent after compound fractures, is seldom so considerable as to destroy the new-formed bone wholly, though often in part; these are the causes of bad ulcers, and of what are called foul bones. It most commonly occurs from a fault in the general system, as scurvy; and upon this principle, sloughs take place soonest in new-formed parts, the separation depending on ulceration.

For the cure of these cases we must first examine into the causes: if from scurvy, when the patient is at sea; or if from their depending position and too much exercise, when the ulceration is in the legs; in which case rest and a horizontal posture are to be used; but

there is something very peculiar in the lower extremities; they will become better and yet again slough.

Of Fistulæ in general.—The term fistula gives a very inadequate notion of the disease, the fistulous canal being only the sign of the disease,—the means of conveying a fluid or extraneous matter to the surface.

A fistula is the consequence of the powers of a part not being able to remove the original cause, so that the original cause and some of its effects remain.

The causes of fistula are various, but may be divided into two classes: first, the obstruction of the passage of some natural secretion, as fistula of the parotid gland; or of the canal for the passage of extraneous matter, as the intestines being strangulated so as to mortify, or being wounded; but all obliteration of the ducts where the fluids make a new passage will not be termed fistulæ: secondly, the formation of pus or extraneous matter in a part requiring a passage, as in fistula in ano, fistula in the joints, and fistula from diseased bone.

We shall first consider the first cause of fistulæ.

1st. The obliteration of ducts, or canals, is the first cause. This arises from obstruction of the natural passages, in consequence of which a new one is formed for the passage of the natural secretion. These obliterations often arise from a thickening of the sides of the ducts, as in the urethra, nasal duct, &c., from inflammation; sometimes from the venereal disease or scrofula; and sometimes from accident, as in the parotid duct. These obliterations are often very troublesome, obstructing the evacuation of the natural secretions, which is very teasing to the part, and when complete is very serious in its consequences. In most there is a new passage when complete, which is made by inflammation and ulceration; these new passages are called fistulous: the discharge is the natural secretion, mixed with the pus from the inflamed vessels of the sides of the passage. If this new passage answers all the purposes of the original one, it cannot well be called fistulous; when from a mortified or wounded intestine, it is called an artificial anus; when in the perinæum, it is for the passage of the urine. There are often accumulations of secreted juices besides the above, arising from the same causes, and producing the same consequences, yet not called fistulous.

Of the Fistula Lachrymalis.—This arises from an obstruction taking place in the passage of the tears from the lachrymal sac into the nose. The causes are often foreign to the nature of the parts themselves, as the small-pox or measles. This I suppose not to originate, as has been supposed, from a pustule at the end or mouth of the duct, but from inflammation running along the duct and causing the sides of it to adhere; it also may arise from ulceration of the duct from a venereal or scrofulous disposition in the part; but most frequently from obliteration of the canal from inflammation. The tears not passing, the inner surface of the sac becomes stimulated

by pressure and distention, and the salts of the tears, which have little or no effect while the sac is natural, when diseased irritate it and produce inflammation. The sac swells, suppurates, and opens externally, and discharges the tears by this opening till the natural passage opens or a new one is made. If the os unguis had been susceptible of the stimulus and had ulcerated, it would have been fortunate, but it only thickens to defend itself from the disease; for we find Nature has made internal parts less susceptible of such stimuli, the ulceration only taking place next the skin, so that it would perhaps be better for us if Nature would sometimes vary from her usual course. This internal thickening is sometimes so great as to unite the external part of the nose to the septum, and render the operation of perforating the os unguis less successful. Opening the old passage seldom succeeds, as it is very liable to become diseased again, as in strictures in the urethra, which are so apt to recur; and here bougies cannot be had recourse to, occasionally, as in the urethra. The operation, however, should not be done precipitately, as the duct often clears of itself and the patient gets well.

Of the Obliteration of the Ducts of the Glands of the Lip.—These glands lie immediately under the skin of the lips, and when there is an obliteration of any of these ducts, a tumour is formed, which sometimes bursts of itself. As the secretion goes on, the new opening cannot heal, and it is then, though improperly, called fistulous, as it does the office of the natural passage, and yet is often stopped again: sometimes they do not burst, and I have dissected them out; for although they occasion little pain they are very troublesome.

Obliteration of the Ducts of Cowper's Glands in the Female.—This may be the case in the male, and probably would occasion fistula in perinæo. An accumulation of slimy matter takes place, and the ducts swell just under the skin, on the inside of the labia, near the carunculæ myrtiformes. They increase in size, and sometimes are mistaken for hernia: they should be opened before becoming very large, by a crucial incision: and to prevent their union by adhesion after opening, they should be touched with lunar caustic: perhaps a round hole made by the lapis septicus would answer better than an incision. They first appear like a little encysted tumour, which increasing, becomes so troublesome as to prevent the person sitting. A lady had a very large one, which was taken for a hernia of the foramen ovale. She went to Paris, where it was thought an abscess and opened.

Obliteration of the Duct of the Parotid Gland.—The parotid gland, from its superficial situation as it passes over the masseter muscle, is very liable to be wounded. Such a wound will afterwards become the orifice of the duct, and will heal in part, to a fistulous size: the duct itself going to the mouth probably closes, as the saliva must then be lost; and as its flowing here is very inconvenient, it is necessary to direct it to the mouth, which may be done with a needle, threaded with a round thread passed to the

bottom of the fistula, then directing it to the mouth and feeling for the point internally, pushing it to the finger and drawing it through, leaving the thread in; and perhaps it will be necessary to bring the thread out of the corner of the mouth, and to tie the two ends externally. The thread should be left in till the new duct has lost its healing disposition, and then heal the external one; but it may perhaps be necessary to make it a new surface before it will heal by making the fresh surfaces adhere by placing them in contact.

2d. The second species of fistula, or that from disease, arises from the disproportion in the disposition to heal of different parts, viz. the internal and the external; the skin healing, while the deeper-seated parts, or seat of the disease, have no disposition for it. It may arise from two causes: 1st, from any extraneous substance in the inner parts; 2dly, from a diseased state of the original part, when the disease formed. The first happens in large deep-seated abscesses, which are prevented healing at the bottom by the pressure of the matter. The second has two causes, the first from the part being naturally indolent, as tendons: the second from a disease in parts naturally ready to heal, but the disease being deep-seated, the skin is more ready to heal than the bottom of the fistula, and thus obstructs the necessary free discharge.

Fistula in Ano—Generally originates two or three inches up the side of the rectum. The first process is inflammation, and the formation of an abscess; then the matter comes down by the side of the gut, and opens on the buttock. Sometimes the gut is so diseased as to give way, and then we have an opening into it, which being the easiest and readiest way for the matter, it is thus discharged, and then we may have no external opening; but if there has been one, it does not heal. The cellular membrane about the anus is sometimes the seat of encysted tumours, which are mistaken for fistula, although they do not proceed from inflammation. The treatment differs in these two very considerably; the tumour is often opened or breaks, but the inner surfaces of the two are very different. The abscess only requires opening, and then cures itself; but the encysted tumour, when opened externally, generally becomes fistulous, and opening into the gut will often not succeed, if attention is not paid to make them heal from the bottom; therefore it is necessary to keep them well open by dressing, or the two divided parts will unite at the edges after opening. When a fistula in ano has both an external opening and an opening into the gut, surgeons are in general satisfied with opening from one to the other; but the fistula sometimes runs higher up by the side of the gut than the inner opening, and then we should not attend to this opening, but get to the bottom of the sinus.

Fistula in Perinæo.—In whatever part of the urethra the seat of the disease is, whether the prostate gland, or the membranous or bulbous part, the external opening seldom heals as long as the seat of the disease has no disposition to heal. This, I apprehend, arises in most cases from sympathy with a disease in deeper-seated

parts: or, in other words, a deep-seated disease is capable of stimulating superficial parts, so as to prevent the natural action for healing. Let us compare this disease with the state of parts after lithotomy. If the incision is made in sound parts, and the whole injury be a stone, which is extracted, the parts readily heal, in spite of the urine passing through that channel. This, then, shows that there is another cause of their not healing. Now if the parts higher up are unsound, as the prostate, &c., though the incision was made in sound parts, it does not heal: if perchance it does, the disease still continuing, you will have probably two or three fistulæ. If the parts are unsound beyond the fistulæ, you will be continually plagued with a return of them. Bougies should not be kept in too long, as they sometimes make fresh fistulæ in perinæo. Several fistulæ may arise from one disease. A diseased bottom may have many fistulous sores leading to it both in the perinæum and anus: and if one of these be laid freely open, so as to expose the diseased part, the rest will heal.

When the disease is in one fixed part, there is a canal leading to it, which I have called a fistula; but if more than one, these different ones are called sinuses. A fistulous orifice is generally a small opening in the skin, having no sore surface in view, and is easily distinguished from other sores; if the diseased part is deep and of long standing, the external skin will be thickened more or less near the orifice, from the contraction of granulations within the canal, so that sometimes there is a protuberance even by the contraction. But this appearance is also common to all diseased parts some way under the skin, when the skin does not partake of the disease; when it does, this appearance is less considerable. If near a bone, this is suspected to be affected. When the seat of disease is near the skin, as when on the tibia, then we may be certain the diseased cavity below is not large.

The cure of fistulæ consists in first removing the immediate cause; for frequently they get well by simply removing the obstruction. In fistula lachrymalis, a new opening, or the restoration of the old one, is the cure. A fistula in perinæo will often be cured by stretching and dilating the canal of the urethra by bougies, which removes the obstruction. The cause of our first division of fistulæ, arising from confined matter, is sometimes easily removed, but not always, by opening the suppurated part in the most depending situation, when, if the parts are readily disposed to heal, a cure takes place. The second, from a diseased state, must have the disease removed or extirpated if possible; but this is often impracticable. A perfect exposure is the next object; but the case will not often admit of it, and then becoming incurable it sometimes produces hectic, as in lumbar abscesses, and abscesses of the liver, which open externally but cannot be exposed. The constitution in such cases is to be most attended to, and everything done to lessen the irritation; but in most cases life is miserable, and we only protract it a little longer by our best efforts. Fistulas in the lungs and liver in consequence

of abscess, and in the intestines from old obstruction, can only have their orifice kept open for the discharge of the matter. Fistulas in ano are generally easily come at, and are then of easy cure. At first it is simply an abscess from disease on the outside of the rectum; if not, it becomes so by inflammation and suppuration. This is proved by the cure, which is not simply a free opening where the abscess points, but opening the abscess from its original seat is necessary for the cure: slitting up the gut to the origin of the abscess is necessary in all cases of fistula in ano.*

Of the attention necessary in diseased and wounded Joints respecting their motion.—I shall now speak of the preservation and acquirement of motion in joints when diseased, and after disease. We must consider in both the necessity of removing the first cause of the disease, or we shall be increasing it by endeavouring to preserve or to acquire the lost motion: nothing can promote contraction of the joint so much as motion before the disease is removed. In healing wounds in general, and especially those connected with joints, great attention should be paid to the motion of the joint: when all inflammation is gone off, and healing has begun, a little motion, and frequently repeated, is necessary to prevent their healing in one position. Wherever there has been an inflammation, a stiffness will remain; but the parts will stretch, and the motion again become free, by gradual motion and friction. But in healing of wounds by granulations there will be more rigidity. When there has been loss of substance, from mortification and gun-shot wounds, there will be still greater rigidity, and consequently more attention is requisite. In violent inflammation there is a union, by a broad surface and close contact, and then motion is sometimes altogether irrecoverable. The parts may often be made to stretch by degrees: this is either by active or passive motion. The active or muscular motion is insufficient, if the disease has existed long, as the muscles often lose the power of acting. The passive or foreign power may be of three kinds: 1st, the hands of another person; 2dly, the addition of matter to the moving part, so as to increase its momentum; 3dly, putting the moving part into such a position as to increase its gravity, which will produce the same effect as the two former; but yet the assistance of the muscles are necessary also. The position is either the middle state of action, which is natural in disease, or it is in consequence of gravity. The arm in diseases of the shoulder, if in bed, lies a little out; but if up, it hangs by the side naturally. Joints are of two kinds, some with flexors and extensors, with a given power; the other have not only the above, but a given support, which support acts generally in the centre of gravity. This division makes a material difference in the position of joints. If in the former of these there is a disease, the part naturally falls into a half-bent state, and will heal so if not prevented;

* [The reason of this necessity is the constant action of the sphincter muscle, which is divided in the operation.]

but it is different in the other kind, for in whatever position they are placed, when there is a weight, the weight becomes the object of the mind, and not the motion; and the joint must be kept wholly in this position, which is a position rather contrary to that which it was meant to be kept in. This is most remarkable in the ankle-joint, because the point of support will not be the natural one: the foot will be hanging in a straight line with the leg, which is just the contrary to that which arises from the elongation of the muscles of the ankle. Suppose the elbow contracted, and I want to put the flexor muscles into an elongated state, neither the muscles nor mind being able to do this; the hand, apparently, is not heavy enough; but suppose I should then put a little weight into the hand, in order to assist a little, then the mind will be fixed on the weight to support it, the flexors will support it, being influenced by the mind; and thus we shall do harm by increasing the power of the flexors. But if the mind is fixed on the extensors, and not at all on the support of the weight, then the weight will be serviceable by extending the flexors while contracting the extensors.

In the endeavour to elongate the muscles in any part of the body, they should never be allowed to contract, which would counteract the elongating powers. In contractions of the gastrocnemius muscle, the heel should be always supported, to take off the mind from the support of the body; the body should be supported by art, by supporting the heel, but this should be incomplete, and gradually made more so. When the knee is bent, the above method will assist when the person is obliged to walk; for when sitting, throwing and swinging the limb about will assist most, and sometimes attaching a weight to the limb. I would advise lying on the face, and with such a position of the knee that the foot should touch the plane on which the body was, and then raising the foot more by bending the knee more. When the contraction is in the thigh, we cannot have all these auxiliaries. With respect to the shoulder it will be much the worst, as it will scarcely be possible to assist its position by any auxiliary. I have thought a pulley might be contrived to raise the arm, with the weight fixed to the end of the cord; or the patient might be requested to lay on that side, having his arm through a tube and hanging out the other side. Every possible method should be tried: if a man could walk on his hands awhile, the arm would then by its own weight come to a right position with the body, which would be sufficient.

TETANUS.

The symptoms of this disease are involuntary contractions of the voluntary muscles of the body, and sometimes of the involuntary, which makes it fatal. This affection is sometimes only partial, and at other times general. When on the muscles of the jaw,

it is called locked jaw ; when on the fore part of the body, as the pectoral and anterior muscles of the neck, *emprostotonos* ; when on the muscles of the back, drawing the head backwards, *opisthotonos*. Tetanus should first be properly arranged as to class and species. It may be properly classed with every unnatural contraction of muscles which may be called spasm, of which there are many species, most of which have some specific difference. It is of the same genus as *spasmus cynicus*, cramp, wry neck, *subsultus tendinum*, &c. It may be also classed with St. Vitus's dance, and it seems to have great affinity with ague, as this disease sometimes attends it ; but the ague is only the predisponent, or immediate cause. It also seems to be allied to catalepsy and epilepsy : these arise from affections of the brain and nerves, but they may arise from different causes. Most of the above diseases are acted upon by affections of the mind, and this is sometimes the case with tetanus. This disease sometimes occurs in animals, as horses, cows, sheep, &c., from which it might be supposed that these animals were subject to it from their way of life being somewhat similar to man's. I had a stag which died from locked jaw, from a compound fractured leg.

Some muscles are more liable to it than others ; those of the lower jaw are the most so ; but as the disease increases, another order of muscles is affected, which I think arises from a species of sympathy : other involuntary actions have also their predisposed parts, as the cramp, which is mostly in the lower extremities. The muscles of the neck are most liable to that species of permanent contractions which constitutes the wry neck.

Of the Causes of Tetanus.—The principal inquiries which have hitherto been made have been on the cure, and not on the nature of the disease, or its similarity to others. This part of the subject I shall now consider, and also in what climates it is most frequent. Irritation from an injury done to a nerve, ligament, or tendon is generally supposed to be the cause, as it generally occurs from wounds of tendinous or ligamentous parts. This at first would seem reasonable ; but we must determine first what is irritation. That is called irritation which excites inflammation, and a patient is said to be irritable when a part of the whole constitution is easily affected by any slight cause. But everything relative to locked jaw does not arise from irritation of the wound itself, neither from inflammation or symptomatic fever ; for in such states the constitution is not disposed to it. It arises from an irritable habit, which may be increased or produced by irritation, but not such as is capable of producing inflammation. When there is inflammation, the locked jaw arises only when that is subdued. When from causes incapable of exciting inflammation, the irritation may be considered the immediate, but not the remote cause ; for there must be a disposition for the disease, such a cause being insufficient for producing such effects : thus also madness is produced

from the slightest causes when the mind is predisposed; so it is in agues and fevers, the constitution being particularly predisposed at the time to such diseases. If it were from inflammation, the locked jaw would come on at first, or when the inflammation is most violent; but then the constitution is strong, which is a state unfavourable to the disease. It is perhaps impossible to say what are all the remote causes which produce this effect; probably many combined; and it would be impossible to give all the immediate, but I shall give as many of both as I have observed.

Constitutions most susceptible of the Disease.—First, there is a disposition of the nerves, and that principally of the nerves of the voluntary muscles and sensation, rendering sensibility more acute in such, so that they can scarcely bear to be touched. This appears to be from irritability of the nerves, and not from irritability of the living principle. To produce the disease only a slight immediate cause is necessary, which is the case also in most irregular actions of the nervous system, as we see in tickling, which will produce convulsions, though these would not be produced by a bruise in the same part. Those most susceptible of the disease are of weakly delicate frames and of suspicious minds, and not of strong and robust ones. It is common to have involuntary actions of the muscles in weakly constitutions, as we see in pregnant women, who are subject to cramps, fits, &c., although the living principle is acting at the same time vigorously; this was also the case with myself, at a time when weak. I threw a stone at a deer, and over-exercised the muscles of the arm, which produced cramp and extravasation in my arm, and loss of the use of the muscles: this produced sickness and paleness, and after a little time cramp came on in my leg; but at last this and the other symptoms went gradually off: if the irritation had continued, a locked jaw might have come on. Now here, from the irritation, a spasmodic affection was produced in a person in health. This species of irritation is very different from irritation of the living principle causing inflammation.

Climate seems the first of the predisposing causes, and that which can probably produce it without other causes: the second is the consequence of considerable local inflammation: the third is irritation. The immediate cause is often a small wound of a part possessing but little living powers. In warm climates it is most frequent, and consequently it is seldom found in cold weather. In the West Indies and in the Mediterranean, besides tetanus, we also find the diseases with which I have classed it very frequent. Sweden, Denmark, and other cold climates are not subject to it. The cramp is most frequent in warm climates, and also in bed: fits also are most frequent in bed, for warmth seems to have a peculiar effect in producing a particular disposition in the nerves; and when there is an immediate slight cause, such diseases readily take place: nay, some are disposed to such actions without any immediate cause, which probably arises from climate, joined with a strong natural predisposition. The cases which I have seen from wounds were

those of the tendons, for these parts heal less readily, and the constitution is much weakened by wounds of such parts, so that sometimes a limb will waste from such a cause,—wounds being much more irritable here than in other parts, and particularly when attended with loss of blood. Nothing produces irritability more than a great loss of blood, especially when accompanied with a wound, and with this disposition of constitution. The wounds producing it are either considerable or slight: the first is a predisponent, the second an immediate cause. When I have seen it from the first, it was after the inflammatory stage, and when good suppuration was come on; in some where it had nearly healed, and the patient was considered healthy, under the disease as well as before. Some have had locked jaw after the healing was completed. In such I have supposed the inflammation was the predisponent cause, rendering the nervous system irritable as soon as it was removed. When it comes on in horses, as after docking, it is after the wound has suppurated, and begun to heal. A young man burned his face with gun-powder: in a fortnight after he was nearly well; but a short time after a locked jaw came on, and continued for two months, and then recovered; but before that time his wounds were perfectly healed. It arises from slight wounds, before either inflammation or suppuration comes on. A man had a locked jaw about a fortnight after a nail entered the sole of his foot, which he did not at the time regard as of any consequence, the wound not being larger than that from bleeding, and not attended with any pain, inflammation, or hardness: he died; and after death I found a black line continued to a hard body under the skin, which could be dissected out almost like a lymphatic gland, and was found to be a bit of leather, surrounded by coagulable lymph: the black line was the mark of the nail. Here was no pain which could be the cause, and little, if any, inflammation, and the suppuration had not begun: hence it appears that the spasm arose from the slight irritation. Would producing a greater irritation have prevented or cured in this case? or would dissecting out the extraneous body have done this? These two kinds of wounds appear very dissimilar: I consider that the inflammation is the predisponent cause in the large ones, and that in the case of slight wounds there must already exist a predisposition, which only requires an immediate cause to bring it into action. The disease oftener arises from slight wounds than large ones, which may partly, but not entirely, arise from such being most frequent. Locked jaw arises from other weakening causes; it sometimes arises at the termination of a fever, and also at the termination of a flux, which is one of the most weakening diseases we have. It is singular that it should begin in the muscles of the lower jaw, and extend from these as a centre; but this is not a

* [We should probably answer this question in the negative, considering that the progress of the symptoms is not in any degree checked by the *entire* removal of the irritation by amputation of the injured part. The fatal result, on the contrary, is generally precipitated by this means.]

general rule, as it has been known to begin in the muscles of the neck. When it is confined to the muscles first attacked it may then be considered as mild.

Tetanus appears to have a dangerous period, in which it is most liable to attack vital parts, which period seems to be before the constitution has become much accustomed to it; when of longer continuance, not having attacked vital parts, its liability to attack them seems lessened, which is generally in a fortnight, as the constitution has then become accustomed to the spasms, and can better bear them: I have never seen one die where it had existed three weeks, and after this it often continues, sometimes for several months. Sometimes they may recover in three days, which is generally the most fatal period; but sometimes they may go on three weeks, and afterwards recover. If violent, it kills about the third or fourth day from the attack.

As it appears to attack parts not necessary to life, it seems strange how it kills; and, seemingly, the patient is in good health at the time without inflammation, and with a good appetite; and, yet, though not starved to death, from the difficulty of deglutition, it kills: however, it is sometimes combined with other diseases, and then it is difficult to say which disease kills; but when it is alone, the following seems to be the case: the disposition increases, and the effect, spreading to vital parts, affects the muscles of respiration, as the diaphragm and intercostal and abdominal muscles, as we see in gout when it attacks a vital part.

The first symptom is a stiffness in the muscles of the lower jaw, or neck; but before the patient is sensible of it, its progress is generally gone some length, not having had occasion to open the mouth wide, for when it is perceived it is probably only by accident: this stiffness makes the articulation imperfect. When the spasm is perceived, a hardness may be felt in the temporal and masseter muscles, and most of the muscles of the face become contracted: if it extends, the muscles posteriorly on the neck become stiff, consequently the head is erect, and generally drawn backwards; the spasm extending to the muscles of the back, it becomes one concave arch, preventing the patient from lying on his back, and a heavy pain is felt at the lower part of the sternum, from the spasm probably of the diaphragm: from this and the abdominal muscles being contracted, respiration is almost suspended, and the pain is similar to that of the cramp. By this pain, and the dyspnœa, we judge of the muscles of respiration and the diaphragm being affected. General spasms next come on, as subsultus tendinum, cold sweats, and death; and it is remarkable that the patient generally, if not always, retains his reasoning faculties during the whole progress.

Of the Treatment.—All the antispasmodics have been given, but without apparent success; opium has kept its ground the longest, but with little reason, as it only quiets; but from some patients having got well under its use, its name has been raised: I have tried it, both in large and small doses, though always unsuccessfully. I

think medicines have no power without they produce some visible effect: opium never removes the cause, though it will prevent the effects; it cures spasms, and removes pain, but it does not remove the cause. It often does good, by not allowing the symptoms to do harm to the constitution. The first appearance of a cure is a recovery of strength, as weakness is a predisposing cause; and the first indication should be to strengthen the system. I should recommend everything to produce extreme external cold, as cold applications, consisting of snow with salt, to the part, and that the patient should be put into an ice-house or sent to a cold climate as soon as possible.* I know of no internal medicine. The pain is somewhat relieved by counteracting the violent contraction of the muscles: opening the mouth by force has eased it; but this has also killed, by causing a translation of the disease: keeping the back bent has also given ease; but these have relieved only in the incipient state. Electricity has a temporary effect, in relaxing the muscles, and in partial affections has cured, by rendering the contractions gradually less violent.

A man fractured his arm, and about a fortnight after had symptoms of a locked jaw. I found several pieces of bone in the wound, which I supposed produced irritation; these I extracted, and gave two grains of opium every two hours, dressed the wound with tinctura thebaica, and over all applied a poultice; he continued as bad as before. The next day I directed bark and opium: on the fourth day he was better; on the fifth much more so, and his pulse good: he was bled, which was repeated on the sixth, immediately after which he fell into a fit, and died in half an hour. This sudden change could not be from the loss of blood, though assisted by it, and by his natural aversion to bleeding: he was of a nervous constitution, and his spirits were easily affected. It was probable that this affection of the nerves was transferred to the heart and brain, and probably the mind had something to do in this business. In another case of locked jaw I gave three grains of opium every quarter of an hour, but the patient died; the opium had no effect, and the muscles were not relaxed by death. On opening him no preternatural appearances were found. In one case I tried *saccharum Saturni*, because lead produces paralysis, and as I conceived the locked jaw a disease directly opposite to paralysis; I gave it in pills, and it produced costiveness, and a peculiar sensation: a glyster relieved him, and he was better, and they omitted the pills because he supposed they made him costive, and would not be persuaded to take any more. He was at last seized in the night with a difficulty of

* [A remarkable case of tetanus, which was cured by an accidental exposure to cold and inclement weather for upwards of sixteen hours, is related by Sir James Macgrigor in the 6th vol. of the *Medico-Chirurgical Transactions*, p. 450. Dr. Elliotson has also alluded to a case of tetanus in a horse, which recovered under nearly similar circumstances. *Med. Gaz.*, Vol. XI., p. 474. It is needless, however, to say that not any remedy has yet been discovered which is uniformly, or even generally, successful in controlling the symptoms of this disease.]

breathing, and spasms on the abdominal muscles, which killed him. In this case I lamented that the lead could not be continued. The ol. animale has been tried, unsuccessfully.

I attended another patient in England, with Sir N. Thomas. Asafoetida and opium were given without effect; these were left off, and bark given in large quantities. Dr. Warren being called in, advised, among other things, a bath prepared of milk and water. After this he seemed better, but died soon after.

I discovered, to my amazement, the different modes of different physicians. Sir N. Thomas had read much, and knew all the antispasmodics from the days of Hippocrates downwards. Dr. Warren having just cured his son of locked jaw, implicitly followed the same practice in this case, being unable to alter his rules of practice in the smallest degree, as occasion might require.

CHAPTER XXI.

OF SCROFULA.

Symptoms well marked, and usually easily distinguished;—a specific disease, but without a morbid poison;—appears to have a sedative quality;—not confined to man;—certain constitutions most susceptible of it;—certain parts most liable to its attacks;—certain ages also;—not proved to be hereditary;—climate a predisposing cause;—and season;—immediate causes numerous. —Inflammation of serofula;—suppuration;—pus;—ulceration;—cicatrization;—difference according to the nature of parts.—Disease of the hip.—Lumbar abscess.—White swelling.—Consumption.—Scrofulous testicle;—scrofulous breast;—distinguished from cancerous testicle and breast.—Cure of serofula;—warm climate;—medicine;—sea-bathing;—regimen;—local applications;—surgical treatment.

SCROFULA is so well marked, and has so many characteristics, that few can mistake it; yet I suspect there are three diseases which have a great affinity to it, viz. spina ventosa, exostosis, and rickets. The first seems to be a pure case of scrofulous suppuration in bones; the two last to be only varieties of serofula. Scrofula is to be classed as a specific disease, but not as a poisonous one. It has, in a degree, the power of making neighbouring parts sympathise, by continued sympathy. It seems to have resident in it a sedative quality, as the disease goes on without any increased action, and from there being no adhesive inflammation. The pus which is formed passes along the interstices of the muscles, and is there even incapable of irritating.

Other animals, besides the human subject, are liable to it, and probably from the same causes; thus, we find a disease very similar to it in young turkeys, and also in monkeys, and I had once a young boar which died of a similar disease; that is, it had swelled

lymphatic glands almost everywhere, and thickenings of the joints, like white swellings : but every constitution is not equally susceptible of it, although probably every constitution is more or less susceptible of it. In some there is peculiar susceptibility, so as to have it produced by a slight immediate cause ; but this susceptibility is lost by age. So, likewise, some parts are more susceptible of it than others. Those most susceptible of scrofula are the delicate, who cannot bear much fatigue or cold without being affected, who are very irritable, and cannot bear strong impressions, as of mercury, who are of irritable minds, light-haired, and of fair complexions. In fair people there is a more languid circulation than in dark, and they would appear to have less red blood. When it attacks after the age of puberty it seems not so much confined to colour. When it attacks dark people I think they have a thin skin. Every part has in some degree its specific disease, and this disease has its parts. Some parts are even disposed to it without the above causes, even by the slightest accident. 1st. The lymphatic glands, particularly the superficial, and those most exposed, as those of the neck and lungs, which last may be reckoned external. As the office of these glands seems to be for giving passage to the absorbents, with their contents, it might be supposed it was only dependent on absorption ; but as this is a specific disease, and not confined to these parts, we must look for another cause, and then too the lymphatic vessels might be supposed subject to it ; which they are not ; hence these glands must have some specific properties rendering them liable to it. Joints also are particularly liable to it, and especially those of the feet and hands, from their having so many joints, with ligaments and tendons. The elbow and knee come in next, and sometimes the hip and shoulder, and frequently the vertebræ. In short, every part is subject to it, but no part more than another, except the above mentioned. The skin has less disposition to it than any other part, for the skin will resist the neighbouring disease for a long time.

Although all ages under the above circumstances are in some degree subject to it, yet youth is more particularly so, for beyond the age of fifteen the disease is less frequent, although it will occur from that period up to forty ; few cases, however, occur above forty-six. In youth it principally attacks the lymphatic glands ; at a later period, the testicle ; and the same things happens in other animals.

I do not think that scrofula can be proved to be hereditary, for if we compare the number of scrofulous subjects who have, and who have not scrofulous parents, we shall find them pretty nearly equal. I have known many families where it has arisen spontaneously, the parents or predecessors having never been subject to it ; and on the other hand, I have known parents who have had it, and their children have perfectly escaped. It certainly often runs in families, but only when the natural predisposition and immediate causes are present ; fair delicate children will probably have it by

the influence of climate. An hereditary disease should act universally; it should pass to all the descendants of a diseased parent; to the dark as well the fair complexioned; to the old and young, and in all countries and climates alike. The children may have the predisposition, but this does not come up to the meaning of hereditary disease. It is only the predisposing cause which can be hereditary. It is hereditary for people to be born with lymphatic glands, but it is not necessary for people to be born with them diseased. Probably a susceptibility of peculiar irritations may be hereditary, as we see in families with regard to small-pox, &c.; but this is an infectious disease. The weak and delicate are incapable of supporting the changes of temperate climates: the most delicate go into this disease, and the parts most subject to it are those which are the most delicate. Climate may be considered both as an immediate and a predisponent cause: the different kinds of weather, as damp and cold, seem to be the great disposers to the disease; however, in cold climates, where there is most constant dryness, it is less frequent. That irregularity of cold and moisture is one of the greatest disposers to it, is evident, from its never happening in warm climates; but the inhabitants of warm climates coming into cold ones often become affected with it. Some parts of the same country are more subject to it than others, which is also the case in other diseases, as agues, consumption, &c. The animals of warm climates often die of indurated lymphatic glands when brought to cold ones, as turkeys, the joints of their toes being first affected, in a similar manner to white swellings. The disease which is called the pip in fowls is also the scrofula.

The seasons likewise have considerable effect; for, indeed, they may be said to form temporary climates in some parts of the earth. Thus, in summer the disease is less frequent than in winter, and often that which is produced in winter is carried off by summer. But the regular cold of winter does not affect these people so much as spring, for the spring disturbs the constitution, and rouses parts disposed to scrofulous action similarly to a slight fever. The autumn has the same effect as the spring, but not so powerful. Every unnatural affection of the constitution has the power, in some degree, of calling forth scrofula; but the disease is never an act of the constitution. Though there is constantly a constitutional susceptibility, its effects are always local. It is a constitutional local susceptibility.

Scrofula appears spontaneously to arise up every day, the susceptibility in some being so strong that by the simple continuance of the immediate predisposing circumstance (climate) they fall into it, without any other immediate cause. The immediate causes are many. Everything capable of producing unnatural actions in a part is capable of exciting scrofulous action where the susceptibility exists; thus, the fevers of small-pox, measles, and chicken-pox often produce it. The lues produces scrofulous buboes; the irritation of mercury in curing the lues produces nodes; cold also

produces it, principally in the glands of the lungs or neck; and strains, gout, and rheumatism often leave the affected parts in a scrofulous state. These causes are more violent than that of climate, and produce the disease usually from a pretty considerable irritation, attended with inflammation arising from the accident, combined with that of the specific kind; but the swelling soon becomes indolent, so that it does not soon get well, and if opened, the sore is still not healable. We should therefore avoid opening it as long as possible. The true scrofula seems attended with little or no inflammation; or if it is so, its sedative quality prevents it from producing pain; but when there is less of the true scrofula, it may give pain; however, it is attended with many of the effects of inflammation, as extravasation of coagulable lymph, producing swelling and also adhesion of the cellular membrane, or of the sides of circumscribed cavities. I have seen the whole of the intestines adhering to the peritoneum, seemingly from a scrofulous cause, and having scrofulous tumours and suppurations in them also: the symptoms were tightness in the belly, without pain and costiveness; at other times purging. The adhesions in the lungs of consumptive people are probably of this kind. Their indolence and want of pain led me to suspect that scrofula has sedative qualities which it gives to the matter, which does not irritate the parts unconnected with the disease. Where the inflammation is visible its colour is of a purplish red, which is a proof of a languid circulation.

The progress of scrofula is commonly very slow, but sometimes the lymphatic glands swell considerably in one night; but then there is a quick and immediate exciting cause, such as cold or fever, in which case there is common inflammation joined with the specific, which soon leads to suppuration, although after the phlegmonous inflammation is gone off it becomes truly scrofulous. The swelling at first is interstitial, but after some time there appears to be a change of structure, as in the lymphatic glands, the testis, and more particularly the bones, the whole bony structure of which is absorbed, so as to leave nothing but a true scrofulous deposit, similar in appearance to a scrofulous gland. When in the extremities of the joints, the part in view is thickened, with little pain; this is principally seated in the ligaments; the joint loses its motion, and the whole limb becomes weak and wastes away.

Scrofulous suppuration is very imperfect if it is truly of this kind, and there is often none at all. The extreme parts may lose their life entirely; yet they do not mortify, but form a curdly matter, similar to that in encysted tumours. This want or loss of life, if there was no specific action, would cause inflammation, as other dead parts would; but scrofulous parts are incapable of this stimulus. Many scrofulous tumours suppurate and ulcerate, especially when near the skin; but this is not entirely the suppuration of the original disease, but from the inflammation of the neighbouring parts. The matter, like common matter, is often a mixture

of pus with coagulable lymph, which last is often most in quantity, it is a kind of glairy and often a curdly matter, being a mixture of the solid parts which are dead with the vitiated secretion. The ulceration is generally very slow, and when near the skin is often stationary, even after the appearance of redness; sometimes it will remain in this state for several months, with a broad surface, not coming to a point, the skin assuming a shining purplish hue; but there is no absorption of the matter, as is generally supposed, from the scrofulous indolence. It seldom happens that granulations form, the sore remaining months, and sometimes years, without any. When formed, they look transparent, as if loaded with water, and have little power of contraction. The cicatrization is as slow as the other processes, from the essential and leading steps to it being backward. The skin around loses its natural elasticity, and so does not give to the contiguous granulations a skinning disposition.

To describe the appearance of scrofulous tumours and sores is impossible, but we can easily distinguish them by sight. A scrofulous swelling generally begins in one of three ways: first, by a circumscribed tumour; secondly by a more diffused tumefaction; thirdly, by suppuration, without any tumefaction. These all frequently appear in the same person at once. The first is seated in the lymphatic glands, and assumes this form from the part being circumscribed, and also because the parts do not give the stimulus by contiguous sympathy to the adjoining dissimilar parts; but there are some which seem scrofulous, and yet are not in the lymphatic glands. These I have called tumours; as, for example, those in the uterus, the breasts, &c. Of the second kind are scrofulous joints, and the diffused swellings on the skin, toes, fingers, hands, and also on the testicle; although, when the whole testicle is affected, it is generally circumscribed. Of the third kind are certain loose bags of matter, without any tumefaction to distinguish them, although near the skin; these are often pretty deep, and therefore are adapted to the parts they are in. There is no true adhesive inflammation in these cases, when they occur in true scrofulous habits. In the breast it begins like a scirrhus, and is sometimes taken for one; but it has no pain, and is so gradual in its growth that it produces no tumour in the axilla, so that it may be safely removed. In the testicles it often goes off and returns again. The second kind, when near the skin, often ulcerates, and hollows the skin by the cellular membrane, giving way more readily than the skin; so that when suppuration comes on, the swelling does not subside, as in other cases. When in a bone, it is generally very slow, and the matter consists of a curdly substance. If the bone is dead, exfoliation is very slow, and in such cases the bone is eaten away by the exfoliations, as we mentioned when on the subject of exfoliations; that is, the absorbents of the surrounding granulations take it up.

The different appearances in scrofula will vary according to the

nature of the part, and to these we have given different names; scrofula in the joints we have called white swelling; in the loins, lumbar abscess; in the lungs, consumption; in the hip, hip-case. Some of these are not suspected to be scrofulous. When it attacks particular parts, it produces symptoms peculiar to the part; but in some parts which are not very necessary to health, it is not easily discovered. If the extremities are attacked, we find a lameness; and if a joint, a wasting of the limb. When it attacks visible joints, it is in general easily known; when it attacks the knee, it has commonly true inflammation conjoined with it, probably from its being frequently excited by accidents.

Disease of the Hip.—In most cases of lameness, or wasting of the lower extremities, the affected limb appears longer than the other, in consequence of the patient pressing most on the sound limb, and putting the diseased one further out from the pelvis, so as to raise the ilium. This is particularly the case in diseases of the hip, although the leg is not found to be longer than the other, if the patient is laid on the back. It arises from the centre of motion in the pelvis being rather altered by habit, which is removed if laid on the back. But sometimes, when the muscles are much wasted, the limb is shorter, which I cannot account for, nor why the limb is sometimes drawn up more, and sometimes put out further than the other. Mr. Cline says the limb is actually longer and shorter in different stages of the disease, and accounts for it thus: in the first instance, inflammation takes place in the ligaments of the joints, occasioning the parts to swell, and a large quantity of synovia to be accumulated in the joint, which displaces and pushes out the head of the femur, thus occasioning a lengthening of the limb; but as the disease advances, absorption takes place, not only of the accumulated synovia, but also of the bone itself, with the surrounding ligaments; and the head of the bone being drawn into the new enlarged cavity, by the action of the gluteus and other muscles, occasions a shortening of the limb; and this lengthening and shortening of the limb is peculiarly evident on laying the patient on the belly. The glands in the groin of the affected limb becomes enlarged, from absorption of the matter. The first appearance of scrofula in the hip is announced by a weakness in the limb, followed by a wasting; but sometimes there is a thickening of the surrounding parts before suppuration comes. It is sometimes difficult to distinguish it from lumbar abscess, which I shall next proceed to speak of.

Lumbar Abscesses.—The mode of their coming on evidently proves them to be scrofulous: lumbar abscess comes on almost insensibly, but sometimes the patient can remember a pain in the part, a pain on the knee, or a pain on the outside of the thigh, leading to the foot. These are often called growing pains, which shows that the disease is affecting other parts; which symptoms, arising from sympathy, are often more severe than the original disease. The progress is often so slow, that the weakness is frequently not

apparent even when matter is approaching the surface, as on the thigh or loins. It often arises or is caused by injuries, as strains; in which case it is attended with more than usual sensibility and weakness. Its occasional removal by sea-bathing proves it to be scrofulous. It seldom occurs after thirty years of age, except from accident, so that it is most frequently met with in young subjects, who have other symptoms of scrofula.

White Swelling, in its beginning and progress, is generally similar to other scrofulous cases; swelling, as it were, upon the part, and occasioning stiffness. There is sometimes a fluctuation with pain, but then it is not truly scrofulous; the pain is sometimes scarcely perceivable, but at other times it is considerable. These cases are of two kinds, one of which is truly scrofulous, the other is only common inflammation, mixed with more or less of scrofula; the latter terminates in adhesion or suppuration. In scrofulous sores on the fingers of children, the pieces of bone are often destroyed, and come away insensibly, the finger becoming shorter and alarming the friends, to whom it is necessary that we should explain the circumstance.

Of Consumption.—Most consumptions are of a scrofulous nature, which is evident from the attending circumstances and cure. They are very frequent, in this and other scrofulous climates, in the fair and delicate, and in the young and middle-aged. They come on generally in a true scrofulous way by catching cold. By this the glands in the neck are enlarged, at the same time that tubercles form in the lungs, which afford a scrofulous secretion, or are converted into a curdly substance, which in the end ulcerates and opens into the bronchi. Sometimes they occasion pain, and generally a cough, difficult respiration, and expectoration. The pain is considerable if the immediate cause is violent, as great cold; and the dyspnoea and cough will be according to the degree of inflammation. The spitting varies according to the inflammation, being at first mucous, but after ulceration is formed purulent. The patients generally die; but as all consumptions are not scrofulous, we should distinguish them. The diagnosis may be formed by the violence or mildness of the attack; by the slow or rapid progress of the disease; by the degree of pain in some one part, and by the hardness and quickness of the pulse, &c. Spitting of blood, which is sometimes violent, at other times trifling, is not always followed by a consumption. Does this bleeding arise from a disease in the lungs, or from a small vessel giving way? I cannot answer this question; but this I know, that such symptoms often precede a consumption. If the lungs are affected, the symptoms will arise from the functions of the part being impeded, as difficult respiration. When we examine consumptive people after death, we generally find a true scrofulous appearance; and as it is clearly scrofulous, it admits only of one mode of cure, which strengthens the opinion of its being scrofulous. The physicians here keep their patients as long as they can, and then send them away to Bristol and other places to

die. But, if we see the symptoms pretty early, and consider it as scrofula fallen on parts which are essential to life, we should not trifle with it as with a finger; we should send them to a warm climate at once, or near to the sea-side; for bathing and short voyages tend much to cure scrofula, and consequently to cure consumption. Bleeding, however, is often necessary, to proportionate the quantity of blood to the quantity the lungs are able to circulate; otherwise bleeding is very injurious, as tending to produce greater weakness, when already great delicacy exists.

Of the Scrofulous Testicle.—The testicle is the next part in order of susceptibility for the disease, and when so affected has been often supposed to be cancerous. Scrofulous testicles begin with out any visible cause, are slow in progress, and are often cured by sea-bathing: when they suppurate, the suppuration is scrofulous. I have seen them in lads of sixteen years of age, but never sooner; from whence we might think that they are not scrofulous. They are seldom seen in old people: for as the action of the testicle before and after puberty differs, its diseases probably differ also.

Of the Scrofulous Breast.—I have only seen one truly scrofulous breast, which came on at the age of twenty-six, and increased gradually to thirty-eight. It was sixteen or eighteen pounds in weight. In this case there was no disease leading to the axilla, as in cancer; so that I dissected it out, and it healed kindly, although the patient had other scrofulous appearances at the time. It was perfectly circumscribed, which is never the case with cancer, when of any size. Cancer may be so at first, when small and loose in the cellular membrane; but when as large as a large egg, it affects the surrounding parts, and is more diffused. True scrofula, however, if attended with inflammation, will also adhere, and diffuse and lose itself in the surrounding parts, so as to put on a cancerous appearance.

Diagnosis between Scrofula and Cancer in the Testicles and Breasts.—A cancerous testicle affects the absorbents going from the testicle and the spermatic cord; but I do not think that this is universal, since we sometimes find the cord unaffected, but in scrofula it is never enlarged or affected at all. The distinction, however, in some cases, is very difficult. As we operate in cancerous cases because the cord is sound, so we must often do so in scrofulous cases which have no cancerous disposition. In the scrofulous breast we have no thickening leading to the axilla, or in the axillary glands, but in cancer they are thickened from continued sympathy; and this is, perhaps, the best criterion.

From the circumstance of the cancerous disposition spreading by what I call continued sympathy, the surrounding parts being contaminated and taken in with the original disease, the skin in all these parts takes on the same disease with the cancer; but in scrofula it does not do so strongly: therefore when a cancer breaks it spreads, but in scrofula the skin seems rather to have a disposition to heal.

Of the Cure of Scrofula.—The remedies must be directed both to the constitution and to the part affected; but if we had a specific medicine, then attacking the constitution alone would be sufficient, as it is in the venereal disease. As to external parts, the only certain cure is extirpation, and this is very confined and is often improper, because the parts frequently get well of themselves; still we are often obliged to have recourse to this means. Internal medicines have very little power; they cannot alter the constitution of fair people, or prevent the effects of climate, or change the disposition of parts; neither can they make young people old. They can only lessen the susceptibility of the constitution, but do not reach the cause; hence there will soon be a relapse, if they are discontinued, climate being often of itself an immediate cause of the disease.

We can sometimes affect the constitution by changing the climate; but changing the climate will not always effect a cure, for when vital parts are affected it is seldom done till too late. Change of climate is equally necessary in other cases as in tubercles of the lungs, these all depending on the same constitutional disease. Scrofulous patients should go towards the South, or near the sea-side, or take short voyages. Sea-bathing in consumption appears tremendous, but it should be adopted in a warm climate. When these means cannot be complied with, strengthening remedies are useful, as bark and cicuta, with cold bathing; but these have no specific effects. Mezereon seems to have great power in the cure of this disease: a man with a very large swelled elbow, which appeared to be scrofulous, (although he had more pain than is usual in scrofula,) had been under a course of mercury for a venereal affection when the swelling came on; he rubbed it with a liniment composed of acetum scillæ, but with no advantage: he was then directed the mezereon decoction, and soon recovered the motion and natural figure of the arm. The cure was completed in twelve days without any sensible effects from the medicine or the liniment, which he continued to use. A woman with enlarged lymphatic glands of the neck, which did not subside as usual with warm weather, I cured by mezereon. I gave it in the following manner: mezereon root, one ounce; water, six quarts; liquorice root, half an ounce. Boil down to four quarts. Half a pint to be taken twice a day, or as much as the stomach will bear.

Sea-bathing seems to have the greatest specific power. In general it is used in summer; but the disease requires it most in winter. It is to be considered in two lights; first, as a simple bath; secondly, as to its specific quality. Baths are of three kinds: cold, warm, and tepid; the specific effect being the same, whatever may be the temperature. When other diseases attend scrofula, for which baths of certain temperatures would do harm, the sea-bath should be regulated accordingly. In some constitutions a different degree of warmth is suitable from what is suitable in others. In some cases two good purposes may be answered, for in some the cold and

specific are both wanted, and in others the tepid and specific. The directions for sea-bathing are in general insufficient, but they should be particularly attended to, as with some the cold bath will disagree independently of all disease; some will be rendered cold all day by it, though they will recover by its specific effect, which is always the same in all constitutions. I do not think that the sea-bath lessens permanently the susceptibility to the disease, but that it is a temporary cure for the present diseased action, and prevents the effect of immediate exciting causes; but after leaving it off, the susceptibility returns, and the disease often returns in winter after a summer course of bathing. Next to sea-bathing and mezereon, hemlock seems to have the greatest specific power. Burnt sponge has been recommended, but I am in doubt of its specific powers. Mineral alkali is serviceable, but its specific powers are very weak.

Warm clothing, and that next the skin, is most proper, because it keeps the warmth constantly the same. This is Nature's method in the cure of animals, and it should be particularly attended to in children: the outward clothing may be according to people's fancy. Children of this disposition should never expose their naked feet to cold and wet, as is frequently the case. The exercise should be gentle, and the diet principally of a vegetable kind: but I consider this of little service, as the disease is frequent in those countries where little else but vegetable diet is eaten.

From the indolence of scrofula we might *à priori* think that many local applications would be serviceable, especially those of a stimulating kind; but these all prove injurious, as mercury, copperas, balsams, &c.; indeed, few applications are of any service. I have myself only found benefit from cicuta and sea-water. The juice of hemlock made into a poultice is serviceable after suppuration has come on; and poultices made with sea-water have done good, when the cicuta has failed, especially in white swellings, before suppuration has taken place; and I may also mention that this water, as a lotion, applied to sores, often gives them a healing disposition.

The best surgical treatment for those cases which will not admit of removal, is to do nothing. Where suppuration is superficial, openings into the abscess should not be made, as they are often absorbed spontaneously, and when they break of themselves they heal the soonest: but exceptions may arise, as when an opening is required to extract an exfoliated bone; otherwise openings only add to the causes which produce such diseases. Those parts which cannot be removed, as lumbar abscesses, are generally incurable; and the question is, are they to be opened or not? The only answer I can give is, that before opening them patients are generally pretty well, but immediately after opening them they become unhealthy and hectic, which continues till death. Hence the practice of opening them shortens life; but sometimes they get well by this practice, that is, perhaps, about one in a hundred; and it may be thought right to treat all as if they were curable, as we cannot

distinguish; this must be left to the surgeon and the particular circumstances of the case.

The common effects of surgical treatment will not be found to arise in cases of scrofula; cutting always does harm. In common indolent abscesses, free openings is the best remedy, and the production of as much violence as we can; but this will not do in scrofula and cancer. In scrofula, irritable inflammation frequently supervenes, or erysipelas extending to the cellular membrane, and produce sloughing: for we find that no violence can increase the restorative action without also increasing the original disease. We find few actually die from the disease, although the vital parts are attacked. When the lungs are affected, it is the difficulty of the respiration which kills; when the mesenteric glands are affected, death happens from the want of nourishment; when there is lumbar abscess, the constitution is worn out by long-continued discharge and teasing complaints; but when superficial parts only are affected they generally get well. Accident produces many visible causes of cure, as fevers, &c.: and probably many invisible ones too. Climate is often a cure as well as a cause of the disease. Children are most favourably situated for a cure, from the daily variation of their constitutions. Puberty often produces a cure, which may be called the natural, and is most manifest in women. When the disease begins at a later period it has not these resources, but is more tedious.

CHAPTER XXII.

OF MORTIFICATION AND CARBUNCLE.

Mortification;—death of parts;—accompanied by pain:—with or without inflammation;—treatment.—Caustics and cauteries.—Carbuncle;—peculiarity of situation;—often numerous;—attacks free livers;—appearance, progress;—constitutional and local treatment.

THE effects of life are preservation and action: death is the loss of both. Life may exist in the whole, or only in a part; but it must always be in a vital part. Other parts may be dead, without affecting materially the machine. The immediate cause of death in a part would appear to be a loss of circulation: this may arise in various ways, but it must be the effect of some cause. Mortification is very different from universal death: the loss of natural life arises from some universal action having taken place, the same structure still remaining; but it is altered in mortified parts, all is blended in one mass of animal matter, and cannot possibly be injected.

Partial Death, or Mortification, arises from various causes, yet

there is probably in all of them some cause which may be called specific. There are many others which may be considered as immediate and remote causes, as happens in gout, which may be produced by many causes, yet the specific cause has a peculiar mode of action in this as it has in other diseases. Mortification is commonly attended with great pain, characterised by burning, and, if it is in view, the stagnation of blood in the vessels always produces a livid colour. The same burning sensation takes place from pressure, if carried sufficiently far to produce mortification, and is familiar in people's heels after lying long in bed. There are two kinds of mortification, one without the other with inflammation. The first arises from causes less visible than the other; that is, there is no increased action, or sensible heat, although the burning pain is considerable. What the predisponent cause is I cannot tell:* I have suspected something like a spasm of the small vessels, but I cannot be certain: we know spasms will sometimes threaten mortification, as we see in priapism, by which I have seen mortification produced in a dog. When the disposition is present, the action goes on; as we see in sores, some parts being of a purplish hue, and going on in this way, while health is in the other parts. In some of these cases, a part withers and dies, and does not stimulate the living parts, so as to produce separation, for a long time; but I have seen too few of these cases to judge of them accurately. The second kind seems to arise from a change taking place before death. Inflammation seems to be the immediate cause; but this inflammation has two remote causes, of which one is weakness, which is the commonest cause of mortification; but the other, or that which produces carbuncle, is not well known.

Inflammation sometimes depends upon an increased action with increased power of the vessels; but in mortification it must depend on an increased action with diminished power; in all cases where this kind of mortification takes place, we have evidently a deficiency of the animal powers. In young people, mortification is generally preceded by fever; in old by debility; and the weakest parts generally give way first, as the toes. But debility alone does not produce mortification, if there happens to be strength in the part sufficient for the action which is induced: debility, therefore, is only a predisposing cause. We see this in scarifying anasarctous legs, in weakness from accident in weakened parts, in bruises, in frost-bitten parts, or wherever action is produced beyond what the powers of the part or system are able to sustain. But the increased action is not necessarily inflammation; it may be a salutary endeavour of the part to restore itself; which salutary action the powers of the part cannot support, and hence it gives way and dies. When frost-bitten parts are exposed to heat, the debility is

* [Later observations have rendered it highly probable that dry gangrene always depends on a more or less complete obliteration of the great vessels: either the arteries or veins, but particularly the latter.]

increased by the necessary action, which action the strength of the part cannot bear. Heat is congenial to life ; but it should be proportioned to the degree of life, otherwise it will increase the debility. On this principle it is that cold air is so serviceable to people weakened by disease. In frost-bitten parts, for example, the living principle is much diminished by the previous cold, and heat must be gradually applied, in proportion to the quantity of life which remains ; but as the manifestations of life increase, so should the heat be increased also, otherwise by applying a degree of heat, at once, too great in proportion to the life, the part will mortify, which is invariably the case in man and all other animals ; for warmth induces a more than ordinary exertion of the living powers, which may even be so considerable as to destroy the powers themselves. This proportion of power and action should be attended to in many common diseases : as appears from a case which I have already described.

Parts which have been weakened seem much disposed to take on the continued sympathy ; and the parts, finding this disposition, become irritable, and are easily inflamed, which inflammation produces death oftener than any specific inflammation. Mortification, however, is neither peculiar to weakened habits nor to accidents ; but is often consequent on common inflammation, as in compound fractures. In a state of health the powers are much greater than the action ; but when this state does not exist, either the powers or the action must be predominant. Thus in mortification the powers are too weak for the action ; but this weakened power is produced by various causes, such as old age, accidents, or erysipelas. The skin of such as take on this irritable action is generally opake, and looks withered even in the young subject.

Of the Cure.—If our principles are just, it will be easy to lay down a rational practice. Practitioners have been conscious of the predisposing cause, which is debility, but not of the immediate one, which is increased action. Hence bark, cordials, wine, &c., have been given, by which an artificial or temporary action has been excited ; but this practice produces an increased action, without producing increased powers, and afterwards the debility is greater. Antiseptic substances have also been employed, such, for instance, as preserve dead flesh ; but this is very absurd. The local treatment has been equally so : consisting in the application of warm dressings in the wounds made by scarifications ; thus stimulating parts, the actions of which were already too violent. This practice might be suitable enough in the first kind of mortification, where death comes on without any increased action or effort. Will any thing lessen action, and increase also the power ? Wine will not ; bark is the only remedy of this kind we have : other medicines may be given on this principle, but none of them are so efficacious ; opium for instance is useful, from lessening the action, but it does not increase the strength : it is, as I have ascertained by experi-

ment, more especially useful when applied to the part than when given internally.

Of Caustics and Cauteries.—The death of a part may be produced by a deficiency or privation of the living principle, and is then called mortification; but it may also be produced by mechanical and chemical causes, as bruises, the actual cautery, or caustics. Too much action will also arise from a violent stimulus, as arsenic, and kill a part, and in proportion to the deficiency of the living principle, the sooner will death be induced: as happens in bruises, in which the cellular membrane sloughs before the skin, though the skin is the part which is most injured. The more vascular a part is the greater is the power of life; hence muscles, glands, skin, &c., difficultly part with their life; whilst bones and tendons soon die by exposure, from want of living power to support the necessary inflammation. The actual cautery coagulates the juices, in consequence of which the living principle cannot exist. When caustic alkali is combined with animal or vegetable substance, the compound forms a kind of soap which is soluble in water. The operation of a caustic is not immediately on the living principle, but chemical; but its effects are retarded in some measure by the living principle, so that it acts more rapidly on some parts than it does on others. As no substance acts chemically till in solution, the caustic must first be dissolved, which is slowly effected by the perspiration on the skin. By the application of a caustic, a blister is raised, and serum accumulated, which dissolves a greater quantity of the caustic; and this effusion is the consequence of all irritations, and is intended to get rid of the cause of irritation. Alkalies are in many cases to be preferred, although from their ready solubility they are disused in some cases. Their action is so very expeditious that the presence of the surgeon is required: they ought, therefore, only to be used in superficial abscesses, as they give much pain and spread, and would take up too much of the surgeon's time when the parts to be destroyed are deeply seated.

The caustic alkali, or lapis infernalis, should have its end wetted with water previously to its being applied to the living part; as soon as it is through the cuticle, the cutis effuses serum, which should not be allowed to extend beyond the intended slough, but should be wiped off with an armed probe. It is impossible to say what time will be necessary for this effect, as it will depend on the thickness or depth of the part; but when a very long time is necessary, we may scarify the upper part so as to quicken its effects; and this I may observe is a very ready way of opening superficial abscesses, when near the skin. When we make an issue in this way, we should go as low as the cellular membrane. The common caustic consists of caustic alkali and quick lime, which should be mixed with soft soap, or with liquid caustic alkali, if its powers require to be increased; the concentrated acids are likewise employed, as for example the vitriolic and nitric, which should be applied, like the caustic alkali, by means of a piece of glass, or

some other substance which will not be acted upon. The metallic salts are chiefly employed to destroy luxuriant granulations, as blue vitriol, lunar caustic, &c. ; but if they are used to produce a deep slough, they must be used in powder, mixed with some soft substance. These last substances only coagulate the parts, but do not chemically combine with them, as the alkalies do. Arsenic seems to have both a chemical and a poisonous effect upon the living textures.

Now as most parts are capable of communicating their sensations to the brain, the gradual destruction which caustic occasions produces considerable pain. This may be alleviated by mixing opium, or extractum thebaicæ with the caustic, or by the application of an opiate plaster an hour or two before the caustic, which will have a very good effect, especially in women and children who cannot well bear the caustic long enough to produce its proper effects without these alleviations.* A long while generally elapses before we can bring a cut issue to a proper degree of suppuration, as the means which are employed for keeping it open prevent a good suppuration, by keeping up inflammation; but caustic seems to answer better, by destroying a certain quantity of substance, which separates in the form of an eschar, and leaves an open sore that will generally suppurate freely. In some the eschar is slow in separating; in others it will be thrown off in about ten days; but in others it will require three weeks, the separation being always more rapid when the caustic goes fairly into the cellular membrane, which has less life than the cutis.

The separation of a dead part from a living is performed by the absorbents, which take into the circulation the edges of the sound parts which adjoin to the dead, and thus the dead part being set at liberty drops off. But in order to effect this, inflammation is first produced, and then ulceration or absorption follows. The separation takes place sooner or later, in proportion to the life of the part; hence the skin, muscles, and parts which are nearest the heart, slough readily: tendons and bones slowly; and cellular membrane less readily than the skin. Life in a part is in proportion to the number of vessels it has for its simple support, the vessels for other purposes not adding to its powers of life, considered in itself. In new-formed parts, however, the separation is not so slow as in original parts, although they are disposed to slough more readily; but this depends on a different principle, viz. on weakness, which is consistent with what has been already observed. How far the brain is capable of sloughing I cannot determine, but I should imagine that people would never live long enough for this process to take place. In vegetables we find dead parts rot; but they are

* [Nothing is so effectual for alleviating the pain occasioned by potassa fusa, as the application of common vinegar, which immediately combines with the alkali to form a neutral salt. It possesses also another advantage, in restraining the operation of the caustic, which in some instances is very apt to spread beyond the assigned limits.]

not separated as the dead parts of animals, because they have no absorbents; but if they separate, they do so by a process of putrefaction.

Soft parts, when about to slough, first become darker coloured, and if exposed to the air become dry and hard. The separation always begins at the external edge, forming a groove between the living and dead parts; this groove becomes gradually deeper, till at last it is quite through, and the slough drops off. Why the separation should begin at the surface I do not know, except that the external parts are more ready to take the alarm, or that the skin goes through its operations and separates more rapidly than the cellular membrane; but as we find in bones that the exfoliation always begins at the external edges, I cannot offer the above as an explanation. Its beginning from the edge makes the separation at first only from the circumference, but sometimes it is from the centre, as when matter is formed underneath.

The separation of which I have been treating is of two kinds; first, where the cause is constitutional, as in mortifications; secondly, where it is local, as by caustic. To the first kind of separation much attention is to be paid, as the mortifying disposition must cease before the part already mortified can be removed. When the separation is begun, if the parts are small, they may be allowed to go on their own way; but where it is a whole limb, it is necessary to remove it, as the length of time required for the separation would often wear out the patient's constitution. The when and the where this is to be done is a matter of great importance. We should certainly remove the bulk of the mortified limb; but as there is danger of inflammation and fresh mortification being brought on, from cutting the living parts, even though the mortification should be stopped, from the constitution being mended, we must wait till we see a healthy line of separation, and, by the appearance of the granulations, judge of the propriety of amputation. I would recommend removing the part in mortifications of the leg, by cutting into the dead parts near to the living; and after a time, if it be necessary (which can only happen in the legs,) the irregularities can be removed. In sloughs from caustic, practitioners used to cut out the eschar; but as a part remains which requires the same length of time to separate as the whole, nothing is gained by this proceeding.

Carbuncle, or *Anthrax*, is an inflammation of a specific kind, which is shown by its regular termination. It may in some measure be reckoned a cutaneous disease, commonly beginning in the skin. The mortification which takes place in the parts succeeds inflammation; yet it does not always arise from inflammation, attended with general debility; nor does it always take place in the weakest parts, as the foot, but commonly near the source of circulation. That there is some peculiarity in the constitution, is perfectly evident, from the patient being apparently otherwise well, with a good pulse. It seems to be a specific effect of this inflammation to produce death in the part. It most frequently appears on the back or

the neck, and seldom in the fore part of the body, which is very singular. Carbuncles seldom come alone; but seldom more than one begins at the same time, but in succession: I have seen them extend over the whole back. Another peculiarity is, that they seldom attack any but those who have lived above par, especially in eating; in which respect they resemble gout, as well as in the circumstance that they are generally inclined to occur in fat people. I suspect that any irritation, applied to those in whom there is this peculiarity of constitution, brings them on; therefore to an elderly man of this disposition I am cautious of applying blisters. The inflammation is in the cellular membrane, and though very similar to the erysipelatous, is yet very different. It does not produce adhesive inflammation, but runs into mortification, as the erysipelatous does; neither does it produce true suppuration. At first it appears like a pimple or small-pox pustule, in the cutis, the matter of which would seem to penetrate to the cellular membrane, and affect it; but perhaps the disease itself extends to the cellular membrane in the first place, although the first idea is most probable, as there is no adhesive inflammation to prevent that being the case. The tumefaction is considerable, but flat: the cells being filled with pus, mixed with coagulable lymph. The matter approaches to the skin by ulceration; or if very tight, it mortifies. The matter oozes from several openings, like water out of a sponge. At last, in most cases, the cellular membrane dies, and the ulceration in the skin extends. Sometimes the whole sloughs off together, leaving a wide chasm, with inflamed lips. When suppuration takes place, there is continued sympathy in the surrounding contiguous parts, and then the inflammation becomes more of the adhesive kind. The local peculiarities are as follow: 1st, it begins like a pimple; 2dly, the inflammation spreads a little, giving it the appearance of a boil; 3dly, the inflammation spreads under the skin, and a doughiness takes place, the skin itself not being much affected, the tumour having a defined edge, and being six or seven inches perhaps in diameter. The skin now becomes affected, beginning at the first point of the disease, and spreading throughout; little pimples are frequently formed upon it, which often communicate with the cellular membrane beneath. Bounds are at last set to it by the surrounding adhesive inflammation. The practice should be to open it as soon as it begins to form a base, to prevent its spreading further. When it has gone through all its stages the process of cure begins, and it heals as soon as other sores, and one is often healing while others are forming.

Boils, I suspect, are all of the carbuncular species, but less in size, with more of the adhesive inflammation, which prevents their spreading. Boils have another distinction, which is, that they seldom produce suppuration equal to their inflammation; and, as in carbuncle, there is produced a visible slough, so there is a core in boils which answers to the slough. When boils are very large the constitution is in fault, but not so when few and small; they are

then supposed to be salutary. Boils are most frequent in youth, carbuncles in age; yet we find boils in old people; but carbuncles are seldom in people below the middle age.

Treatment of Carbuncle.—As carbuncles begin with a species of inflammation, which terminates in mortification, the patient being generally of a full habit and in apparent health, it might be asked if the constitution should not be treated by evacuants. I would treat it always according to circumstances; but in the latter stage I have always found evacuations improper. Evacuations never answer in constitutional specific inflammations, as they do in common inflammations. Bleeding in gout and erysipelas is often very injurious, yet it is occasionally necessary; neither in inflammation from poisons has it a good effect, unless where the constitution is ready to run into violent common inflammation, in addition to that produced by the specific power of the poison; hence, in small-pox, gonorrhœa, &c., bleeding is sometimes useful: but evacuations and bleeding never agree so well with those who have lived above par as in the temperate; hence they are more useful in acute rheumatism than in acute gout. Cordials and bark, and warm medicines, are commonly given, and made more stimulating by the addition of tinctures; and these are given for two reasons; first, because the part is dead; and secondly, because the patient often becomes much debilitated. But such medicines can only keep up the strength and the action depending upon strength, but cannot overcome the specific nature of the disease: therefore we should give others, that we may at last find out a specific; yet, if we had a specific, these remedies would be often also necessary, as they are in lues. I have, however, tried other means, but with little success.

A gentleman, ætat. 70, who had lived well, and had had a universal dropsy, which he appeared to be cured of, was attacked with inflammation on the left shoulder, which turned out to be true carbuncle, which, as soon as it was opened, was followed by several more near the spot. The person under whose care he was gave him one drachm of powder of bark with ten drops of tinct. thebaica every hour, which rather purged him; he also took calomel and opium, the former of which was increased, to see if mercury would do good; but it had no effect; neither did it prevent more from forming. One was very large, and there were several smaller ones in different parts of the back; one was opened pretty early, which seemed to stop its increase, and I opened another at its orifice, with caustic, which discharged the matter, and seemed to stop its progress. The first during this time was healing. When the first appeared he seemed to be in good health, but afterwards he gradually lost it, his appetite became bad, his pulse quick and small, and his ankles a little swelled. As neither bark nor calomel and opium had been of any use, I said to Dr. David Pitcairn, "Now do not let us permit this patient to be lost, whilst we are only using such means as experience shows to be of little or no effect; let us try something new;

for David, this is a case more belonging to my province than yours, and I, being an older man, have seen more of them than you have, and can tell you what perhaps you did not know, that we have no powers in this case that are known." Now David is a truly sensible man, and not governed by form; he therefore agreed, but wanted to know where we were to begin. "Why, with the first letter of the alphabet, and go through the catalogue of the *materia medica*, so as we do not stop too long on the letter B (*Bark*), as is generally done." As *cicuta* was a medicine of considerable powers, and then not thoroughly known, we began with that, of which the patient took half a drachm in the day, but without effect. I then tried *sarsaparilla*, both in powder and decoction; the powder was made into bread and pudding, to eat through the day, but with no good effect. Dr. Pitcairn now proposed decoction of elm bark, from having seen it of use in erysipelatous inflammation, there appearing an affinity between this disease and erysipelas; this I assented to, but from a thought which had struck me, I wished to try the fossil caustic alkali (*soda*); so they were given together, and we thought they were of service, as it was during this course that the patient recovered, though it must be confessed it was very slowly; but some fresh ones which had shown themselves disappeared again. I have given fossil alkali to several since with good effect. I was myself always troubled with boils, until I took forty drops of this *lixivium* night and morning in milk for two months, when all my boils disappeared, and I have since had no return of them. Another gentleman asked my advice on whom two or three carbuncles had begun to appear, and he was perfectly cured by this treatment.

The topical treatment consists in the free dilatation of the skin which covers the sloughing cellular membrane; but as this comes after all the mischief is done, I think it a bad practice at the latter stage, although applications to the part are useless until the slough is separated. Small openings at the beginning, to prevent the increase, is all we should do, and not make any openings afterwards.*

* [The practice of modern surgeons is to make free openings in all stages of the disease, for which the best reasons may be given. An escape is thus afforded to the diseased sloughs and secretions, and an opportunity given to apply appropriate dressings to the sore; but the propriety of this treatment chiefly arises from the indisposition of the skin to ulcerate sufficiently extensive to allow the sloughs to come out. See *note*, p. 196.]

CHAPTER XXIII.

OF POISONS.

General considerations respecting poisons;—definition of a poison.—Mineral poisons.—Animal poisons, natural and morbid.—Morbid poisons;—their origin;—effects local, constitutional, or mixed.—Of local diseases.—Itch;—nature;—cure.—Cancer, definition of;—origin and progress;—effects only local;—does not affect the constitution;—reasons for this opinion;—extension of the disease by three modes;—absorption of the poison;—does not produce specific fever;—no proof of poisonous disease of the constitution.—Local effects of cancer;—predisposing causes.—First appearance and symptoms of cancer;—progress towards suppuration;—treatment;—destruction of cancer;—extirpation;—mode of effecting it, and cautions to be observed.—Cancerous testicle.—Fungated sores.—So-called cancer of the penis.

No unexceptionable definition of a poison can be absolutely given, for almost everything capable of injuring in a healthy or unhealthy state may be considered as a poison. They are such as destroy either the structure or the functions of an animal. The last may be similar to the weather, which often affects the mind, and may be called a poison of the mind. But there are many substances which, when applied to a healthy state of the body, may injure, as poisons; yet when applied to an unhealthy state they will counteract that state, and keep up health as long as they have the power of irritation. The healthy action, then, being a *tertium quid* of the unhealthy and poisonous, these are to be considered as medicines which have different effects at different times, and under different circumstances, as food; sometimes they are capable of curing one diseased state and not another, even of the same specific disease; indeed, each disease has its own peculiar specific. Many substances act as poisons in some constitutions and not in others; as muscles, &c., thrown into some stomachs poison them; also strawberries and cider in some persons cause flushing and erysipelatous inflammation. Whatever our idea of a poison may be, we must generally exclude the idea of quantity, for even the most innocent substances may become poisonous by quantity, as common food. Some cannot eat meat of any kind without being affected, but can eat fish or fowl without harm. If we do not pay regard to quantity we cannot distinguish poisons from medicines, as many of our medicines may even be given so as to poison or to produce no effect at all. So vague are our ideas of poison that we do not give the name of poison to all the actions of the same substance when it is formed to act in two different ways, though it may kill in both ways. A man killed by swallowing a piece of glass could not be said to be killed by a poison, because we know its effects; but powdered glass swallowed would irritate the coats of the stomach,

and kill, and would hence be called a poison. Many other things might be called poisons, as cold water drunk when a person is hot, producing fever, erysipelatous inflammation, the eruption called a surfeit, &c.

Poison is not only what is taken in by the stomach, but also by the lungs, as mephitic air, which kills immediately, and has no cure; so likewise many applications administered externally are called poison. Our present idea is that they act in three ways, viz. mechanically, chemically, or on the living principle. The two first always act locally, but the third either on the whole or on a part. We do not call everything a poison which acts mechanically, as swallowing a knife; but we suspect a different mode of action from powdered glass or hair, and therefore call them mechanical poisons, imputing the effects to some hidden power, which is in some measure right, it being their irritating effects on the living principle of the coats of the stomach, not simply cutting and lacerating mechanically as the knife does. These ought not therefore properly to be called mechanical poisons. Melted lead or boiling water will kill chemically, yet cannot properly be said to be poisons. Some only irritate the part, the substance being too weak to have any chemical effect. Nor is everything which acts on the living principle to be called a poison; but we should distinguish between poisons of this kind and medicines; yet we find "a slow poison" is a common saying, as brandy. Arsenic kills by inflaming the stomach, and not by a peculiar action, therefore it is not a poison; nor is anything else which kills by common inflammation or common effects. I would define poison to be a substance which has a peculiar mode of irritating, a peculiar mode of affecting the living principle, and which produces its effects more or less in any quantity, however small. Of this kind are most of the morbid poisons; but small-pox falls short of the definition, in not keeping up its effects after having once affected the same person.

Of the different ways in which Animals may be affected by Poisons.—There are three ways of their acting, and also a mixed way. The *first* is where the poison affects only the part in contact with it, and no part of the general system, except from the local injury. This includes the three kinds of poison, viz. mechanical, chemical, and those acting on the living principle. Examples of these are glass acting mechanically, sublimate of mercury acting chemically, and the matter of cancer, which acts only on the living principle. The *second* is when the poison affects the constitution, which constitutes it a morbid poison entirely, as, for instance, the jail distemper; but how it gets to the constitution is unknown. The *third* is when the whole nervous system is affected, as by poisoned arrows, honey, muscels, nux vomica, and probably also the bite of a mad dog, which produces no visible effects on the injured part. The *mixed*, or compound, is of two kinds: first, when it produces inflammation of the part, as was observed of cancer and itch, and at the same time affects the whole constitution, as the venereal dis-

ease, which the cancer and itch do not. The second is that which has three different modes of contaminating a part, like the third class, viz. 1st, locally, as in the itch; 2d, like the jail fever, which acts first on the constitution; and 3d, like the first of the compound, producing local inflammation; of this kind is the small-pox, &c. We might make a fourth out of those in which the poison might be taken into the constitution without producing local effects in the first place, as in jail fever, natural small-pox, &c.; but these are then received by contact, and not by insertion. In some the constitution is unaffected till ulceration has taken place, from knowing which we can often prevent their general effects. How a poison lies inactive so long is with difficulty explained, but it is a principle belonging to each, each having also its own specific latent period before it affects the constitution.

Mineral Poisons.—The mineral poisons are mostly metals, the poisonous qualities of which depend on their solution in our juices; their virulence is often increased by their combination with acids, as, for instance, mercury with the muriatic acid; but they can poison either by affecting the living power, or by acting chemically; chemically when strong, and by irritating when diluted. Minerals are capable of acting in the three different ways; when mechanically, it might be supposed to be by altering the composition or arrangement of the animal fibre, so as to injure without destroying the living principle: but such cannot properly be called poisons. They may act chemically by combining with animal substances, as the vitriolic and other acids, and caustics. When they act on the living principle without seeming to alter the part to which they are applied, they are probably absorbed, and excite universal irritation, as for instance, lead and mercury, which, when given too largely, seem to have this property; but each of these will kill by their action on the stomach. I know of no mineral poison that produces universal sympathy when locally applied, except it is applied to the stomach. Most of them produce peculiar complaints as we see from lead, mercury, arsenic, opium, &c.

The Vegetable Poisons appear to be of three kinds; first, the natural juice of plants without having undergone any secretion; secondly, the secretions of plants, as honey and the essential oils; thirdly, those which have undergone a change by a chemical process, as the oil of tobacco. These produce their effects in two different ways, similar to the mineral, viz. chemically, and on the living principle. Their power on the living principle is much more extensive than that of the mineral, and their effects are peculiar and different from those of any other disease, so that they are generally well characterized.

The Animal Poisons act principally on the living principle. Nothing shows the variety of animal matter more than the poisons. The blood may be considered as the fluid animal, because it contains all the parts which compose the animal, and the whole body is composed out of it. The solids which exist already must have

the power of decomposing this fluid according to the stimulus of each part, and on that the natural and morbid secretions depend. I shall consider these under the heads of natural and morbid poisons.

1st, *Natural Poisons*.—Many of these first affect the stomach, as some kinds of fish; others consist of animal secretions, which are produced by particularly formed organs, provided with an appropriate apparatus and ducts, for the especial purpose of secreting and inserting the poison in the bodies of other animals. These secretions do not affect the parts which contain them, although they would probably poison the animal itself if inserted into any other parts than those which naturally contain them, as, for instance, in scorpions, which poison each other, although the Abbé Fontana denies this as to the viper. The second species produce their effects in two ways, by contact or by insertion. Those which affect the skin by simple touch are various, as sea insects, the ant, &c.; but before the others can possibly operate they must be conveyed into a wound, which brings them to the living principle, on which they will always act under these circumstances, but not when the cuticle is entire; hence all these animals make a wound before they can act. This second species are all of them very active, producing immediate effects, both locally and constitutionally, otherwise they would not answer their intended purpose, which is the defence of the animal. According to the quantity, they would appear to be more or less violent in their effects, as in small animals the effect is the same in kind, but not in degree, as in a large one; thus a large one kills, while a small one does not; the rattlesnake being longer and larger than the common viper, kills much sooner.

Those which poison by the touch, first produce a soreness, and some swelling and inflammation, which latter is of the adhesive kind, although the swelling is generally œdematous. Those which act externally and locally do not occasion swelling at any distance, so that the continued sympathy is not great, as that from the ant. These all appear to have their peculiar distance, unless the effects are increased by rubbing, itching being generally their consequence. Those which become constitutional have also local effects, which, however, are not so fixed as those from the other sort; for in these a kind of continued sympathy exists, and a dissolution of the parts comes on, which produces extravasation of blood, and consequently a dark colour. The first symptom is pain, and if the poison is absorbed there is also a sore red streak, extending to the lymphatic glands, situated between the injured parts and the thoracic duct. The glands also, which are principally in the bend of the great joints, swell, and become painful, showing either absorption of the poison or that the lymphatic system sympathizes. A cold fit often follows, and sometimes convulsions and death in a short time. The injured parts likewise swell, and become dark and livid, from vessels carrying red blood which did not originally do so; but the continuance of the local effects does not arise from the constitution, otherwise

similar effects would manifest themselves in other parts of the body. Suppuration of the part to which the poison is applied rarely happens; but by absorption this may sometimes happen, as in common buboes. Effects such as we have been describing are seen in the viper, scorpion, &c. Some insects poison in the act of sucking their food, as the gnat and bug, and these seem to produce specific diseases; that is, they appear not to suck the common red blood from the vessels, but to produce an inflammation, and afterwards suck the extravasated blood from the inflammation which they have occasioned.

2d, *Of Morbid Poisons.*—These probably arise from a diseased state of the body or part, which originated either spontaneously, or from the application of similar matter from another animal. This is proved by the late origin of all of them. We have many daily arising spontaneously, and which continue their excitement. The cancer is a proof of this, and I once thought the same of hydrophobia; but Mr. Meynell tells me he never had a hound mad but what had been bitten. Some of the morbid poisons are lost, and others are losing ground every day for want of frequent communications: some of these act in a fluid state, and others in a state of vapour. The venereal poison requires contact, and possesses itself of those parts which are most frequently in contact; some affect the secretions so as to make them poisonous, as the saliva in the mad dog. It may perhaps in time happen that the human race shall be extirpated by poisons alone; but it is more probable that many poisons are extirpated, and that new ones arise in their stead every day. Morbid poisons differ from the natural in requiring a morbid action in the body to produce them, as cancer, which is either the produce of a similar disease, or arises spontaneously. These produce greater variety of effects than the natural, some of which are local, and others both local and constitutional.

Some affect the whole system rapidly, as the variolous matter; but not so the venereal. Many of them are not content with simply poisoning those people who come within their influence, but communicate it to others, who in their turn are capable of affecting others. Every part of the body is more or less susceptible of being poisoned. The effects of some poisons seem confined to peculiar animals; as cancer, which occurs only in the human species. Others affect various animals; as hydrophobia, which attacks horses, cows, dogs, cats, geese, fowls, &c., when they are bit. Others only affect animals of the same species, as the variola. Some appear to choose peculiar ages; as the cancer, which never occurs in young people. Many choose a peculiar sex, or peculiar parts only are affected by them, some parts being more susceptible of some actions than others: as, for instance, the breast, of cancer; the skin, of small-pox; and the salivary glands, of hydrophobia. Both the great and small effects of morbid poisons depend less on quantity than those of the natural do. Some poisons perform their own cure, as in those cases where the constitution is only capable of being affected

by them once; which, as we have no artificial cure, is a happy circumstance. But others seldom or never affect the system in such a manner as to oblige it to discharge the poison. Some perform their own cure, when the mode of their action is on a peculiar part, as gonorrhœa.

Of the Modes of receiving Morbid Poisons.—If morbid poisons are applied in a solid state, they must become fluid, by the moisture of the part, before they can act. The manner of receiving them and being affected by them is in three ways: 1st, when the effects are always local and never reach the constitution, as in cancer; 2d, when the constitution only is affected, as in jail distemper; the 3d, or compound, is when the poison can affect one only or both at the same time, as the lues and small-pox. The first is of two kinds: first, when the patient contracts a poisonous disease, either from known causes, or from violence committed on parts which are capable of running into diseased action, and of communicating the same to others, as cancer and lues; the second is where the disorder is external and local, so as to affect only the cutis, as the itch. The manner of receiving the second, or entirely constitutional, may be either by effluvia or contact. The first, or that by effluvia, is owing to the air being impregnated with poisonous vapours arising from the animal body; but how the poison is received into the constitution is unknown, there being no traces of it before it shows itself by the fever, as in the jail distemper and hooping-cough. The second of this division of constitutional poisons is the plague, which is caught by contact; but whether it could or could not be produced by inoculation is unascertained. The mode of receiving the third, or compound kind, is twofold: first, it differs from merely local poisons, because it seldom acts locally at first, as the variola; for we receive this disease naturally without knowing it until the constitution is affected. Secondly, it can affect both the constitution and the part, as the above; but generally there is local inflammation, and sometimes ulceration, previously to the constitution being affected, as in lues.

Of the Itch.—This is one of our first class of the first division of morbid poisons, which affect by simple contact and are always confined to the parts to which they are applied. Scabies never affect the constitution; from which I conclude that it is never absorbed. However it originated, it is now become a common poison. It produces small ulcerations, which are generally much confined; but when the disease is of long standing they are as large as a sixpence, and covered with a scab. First there is a small vesicle, which discharges a kind of matter, which gradually thickens until genuine suppuration takes place; the matter which is thus formed produces ulcers of the same specific kind, although its powers of contaminating are evidently weak, as cleanliness prevents contamination. The irritation of it is scarcely sufficient to produce inflammation, and continued sympathy hardly ever takes place in it. It gives no pain, but occasions a sense of itching. It

is generally caught by shaking hands, or from lying together, as the lower orders of people commonly do, who are most subject to this disease. Uncleanliness aids this effect; therefore washing the hands, even after the matter is on them, prevents the disease from taking place. When it arises from lying in an infected bed, or from a nurse, it is generally communicated to every part of the body; a fact which gave rise to an opinion that its origin was derived from nastiness. The disease has been said to arise from animalculæ; but these, if present, are, I am sure, unnecessary for the existence of the disease, as I have often examined the matter and found no animals in it; yet they may sometimes be in the matter. I forget who was telling me lately that Dr. Teigh had shown them to be, not in the pustule, but in the skin near it, as little black specks. It is capable of affecting the cutis when covered by cuticle, but not where the cuticle is thick. It affects parts thinly covered with cuticle most, as between the fingers, but often no part escapes, making the cure very troublesome; for as the cure is effected by local applications, it then becomes necessary that they should be extended over every part of the body.

Although a specific disease and a poison, yet it has several cures, which act in various ways; but all must have powers to remove the irritation of the disease. Mercury often cures and often fails; yet a girdle often will cure when the unguent will not. Solution of sublimate of mercury sometimes cures, as does a decoction of hellebore. A sulphureous unguent is most efficacious; but it is volatilized by the heat of the body, and is disagreeable. If mixed with water, the smell is somewhat prevented; but it is then less efficacious. Sulphur given internally reaches the skin, and produces a smell thereupon, and will then cure; but to produce this effect it must be given so largely that it is apt to prove purgative: opium therefore should be conjoined with it. Sulphur, however, is the only certain remedy; and when properly used, it may be depended on.

Of Cancer.—The diseases commonly classed under this name are in appearance very different, and probably are very different in their nature; they should not, therefore, be called by the same name. I would call that cancer which produces the following effects; viz., a circumscribed tumefaction with much hardness, and a drawing in of the skin covering it, as if the cellular membrane underneath was destroyed: then a species of suppuration takes place in the centre, and ulceration of the external surface. This is its most frequent appearance. It most commonly attacks the conglomerate glands, and first the female breast; also the uterus, the lips, the external nose, the pancreas, and the pylorus; besides which the testicle is very subject to it, though that is not to be classed among the conglomerate glands. So that when I speak of cancer, I mean a peculiar disease in some of the above parts. There is another disease which is also called cancer, which I have called fungated ulcer. The frequency of a disease in any one part is apt

to lead us to suspect that this one disease is peculiar to that particular part; but scrofula attacks these parts also, in the form of a tumour, and a distinction between them would be a great advantage, although this probably can only be made in the breast, which is subject to both diseases. When small, they probably cannot be distinguished; but as they increase, the distinction is more easy. If cancer, it will vary its appearance by becoming less circumscribed, not having so determined an outline, from the cellular membrane around becoming diseased; the skin will be less moveable, the nipple more or less retracted, and the lymphatic glands going to the axilla will swell. But in scrofula there will be no surrounding disease, no affection of the nipple or axillary glands, no adhesion, even though the tumour be large; I have seen one loose, when it weighed eighteen pounds; the veins become also enlarged. When scrofulous tumours are large, and become slightly inflamed, they get more diffused, and put on a greater resemblance to cancer; but in cancer the inflammation comes on earlier, and goes on with the disease. In cancer, the surrounding parts that are affected by continued sympathy also become cancerous near the skin, that is, all the parts become blended in one mass; but in scrofula, although the surrounding parts are in action, yet that action is not so scrofulous as the part itself; so that the skin will sometimes heal over the scrofulous tumour, as I have seen in the testicle when suppuration had taken place, by which I determined the disease was no cancerous. The tumefaction is from interstitial extravasation of coagulable lymph, and the tumour is more ready to inflame than in the scrofula. Cancer is one of the first class of our first division of poisons, viz. that which only produces local effects, though it has been supposed to contaminate the constitution; which would be terrible indeed, as we have no specific nor even a palliative for it.

The reasons for this opinion are the following. When a cancerous tumour has been removed often, the sore does not heal, or breaks out again. Sometimes it breaks out again in another part of the body; which has been thought a proof of its arising from the constitution. This last circumstance as often arises where there has been no operation as where there has been one; it does not therefore depend on that circumstance as a cause. However, the operation having or not having been performed does not affect their argument, unless they could prove that cancer is an act of the constitution, and acts as a drain or concentration of the cancerous poison, and that by stopping this it must go somewhere else. But the proportion of those who have it break out in two different parts of the body, compared with those who have it only in one, is about half what the latter bear to those who have not the disease at all, or about five hundred to one. I never saw it in two different parts of the same person; but I have seen it in more than two distinct points of the same part. It often arises in distinct points of the same breast, but seldom at the same period; and some of these

may be so much in their infancy when the operation is performed as not to be observable, but afterwards increase and require a second operation.

The surrounding substance of the breast has often little tumours, sometimes containing a blackish fluid; these may be called cancerous hydatids. It is therefore best to extirpate the breast completely at once, to remove the whole complaint. It must further be proved that the continuance of the disease, or contamination of other parts, is not owing to the healing or not healing of the sores. The above reasons for believing it constitutional would satisfy any one not of the profession; but for surgeons to be influenced by them shows an ignorance of the first principles of the animal economy. They should recollect that though it affects the neighbouring parts, and the parts through which the poison passes, by sympathy, producing a similar disease, it does not affect distant parts, like those which really affect the constitution. A scirrhus or cancer appears to have three modes of contaminating: 1st, by continued sympathy, which is common to other diseases; 2dly, by remote sympathy, which is peculiar to itself; 3dly, by contact or communication of its matter to other parts by contamination. I have called these consequent cancers, in opposition to the original. Absorption would appear to arise during both stages of the disease: first, by the absorption of the tumor in a scirrhus state, that is, the coagulable lymph, which possesses the cancerous property; secondly, by the absorption of matter produced by suppuration. Both appear capable of contaminating the absorbents through which they pass, and so far agree with local morbid poisons; but it may be a compound poison, so as to affect other parts, as small-pox does. Whether it is a compound poison I will leave you to judge from the following remarks on the effects of poisons on the constitution.

Whether a poison be a compound one or entirely constitutional, it first produces a fever that is universal, a specific general irritation; and, if compound, local irritation also, which local irritation produces a discharge, as in small-pox and measles, the discharge being similar to the original in these, but not so in the venereal disease.

Let us now see how far cancer agrees with these: if it does agree, it must be a compound; if it does not, it must be entirely local. A cancer in the breast or testicle is similar to the inflammation and ulceration after inoculation, or to a chancre, only differing in specific properties. The matter of lues and variola may be absorbed and cause inflammation of the absorbents, and the cancerous matter is also capable of absorption and of contaminating the parts as it goes along, so as to form buboes, or what I call consequent cancers; so far therefore these diseases are similar. But the above diseases are very quick in their effects, while the cancer is very slow: and so far their cases are dissimilar. The variolous poison occasions fever and an eruption similar to the original one; but the venereal poison does not do this, its effects being merely

local, consisting of blotches on the skin, &c. ; neither does the cancerous poison when in the constitution produce fever, nor is there any local effect which arises strictly from the constitution. Does cancer then produce any effect on the constitution ?

When it has existed a long time we find slight fever and hectic ; but this is no more than the effect of all long continued irritations, or sores which are not disposed to heal, but no peculiar effect is produced from this affection on the constitution. The effect which has been mentioned is produced even by the venereal poison when of long standing, but it is different from the specific. I have seen locked jaw and difficult respiration produced from a cancer in the breast ; but these were occasioned by the irritation of a non-healing sore ; small-pox does not produce this hectic. It has been said that cancers are produced by ill health, as rheumatisms are ; but this arises from the age of cancer being the age of such complaints, and being thus the predisposing cause of both, but not particularly of the cancerous disposition. Let us compare the cure of cancer with that of the venereal disease, when the latter can be extirpated externally. If we remove entirely a chancre, the sore heals readily and does not return, and if this is done before any absorption has taken place, then there will no future disease ; but if after absorption has taken place, and after a bubo has formed, then, although the sore will heal, the bubo will go on, and the constitution will be affected. So likewise, if we remove a cancer, and no absorption has taken place, the sore will heal and the constitution will not suffer ; but then the whole must be removed, as in the local venereal disease, otherwise it will return. If removed, and there has been absorption, the parts heal, though the consequent cancer goes on ; but if the whole cancerous parts are removed, the constitution is free ; here it differs from the venereal ; for there, when absorption has taken place, sores break out in other parts, but this is not the case in cancer. The general opinion has been the reverse of this. This shows that a cure is the consequence of a total removal of the parts, notwithstanding absorption has taken place, if all the diseased parts are removed.

The only powers of contamination of this poison are ; 1st, when it spreads from the centre, thus producing a disposition to the disease in the surrounding parts, and an extravasation of interstitial matter ; 2d, when the disease extends to distant parts, as when little tumours form under the skin at some distance, not in the line of absorbents ; and 3d, when it produces the same disease in the absorbents and glands. This last is easily conceived, from its being a poison ; but the affection of a part that seems to have no connexion whatever with the diseased part is not so easily accounted for.

When scirrhus is entirely let alone, it is commonly very slow. A small lump in the breast may sometimes continue for many years : but whenever inflammation takes place, its progress is accelerated, in as much as inflammation is an increased action of

the part itself, as well as of the surrounding parts; so that if we remove the tumour in this condition the glands in the breast will probably inflame and sometimes suppurate, although often these effects are not cancerous. When inflamed, the tumour increases very fast, but the sympathy is very slow, which is common in many diseases. When distant parts, not in the line of the absorbents, are affected, it would appear that such parts are very slow in taking on the diseased action, although the disposition has been formed, for we frequently see that they do not take on an active form for some years after. In those cases where there is absorption of coagulable lymph, it becomes a question whether the lymph is cancerous, or whether the affection is only sympathetic; most probably it is the last. The last two forms of the disease are generally very slow, which circumstance makes them dangerous, as it cannot be ascertained when parts are really affected with the disease, which often necessitates a second operation, it being necessary to remove all the parts which have undergone the disposition, although the inflammation or tumour itself is circumscribed.

The predisposing Causes of Cancer are three in number, viz. age, parts, and hereditary disposition; perhaps climate also has considerable effect, though not itself a predisposing cause. The cancerous age is from forty to sixty in both sexes, though it may occur sooner or later in certain cases. The testicle for instance, often becomes cancerous at twenty or thirty; but then not from the disposition of the parts alone, but from accident.* Cancer has been supposed to be in young people's eyes; therefore it is most probable that the breast is less subject to it at this age, and other parts are not so much confined to age in this disease. We often see tumours in the breast at thirty, and probably some of them are cancerous, although scrofula is more to be suspected. When cancer occurs in the breast of women under forty, it is more rapid in its progress than when the patient is older, and also more extensive; remote sympathy likewise takes place more readily in them than in the old, so that the operation succeeds better in the latter on this account. However, we seldom find it in the young or very old; although of the two it is most frequent in the latter. When it occurs in the young, does it not show a very strong disposition for the disease, and therefore more danger, from a greater likelihood of its returning?

The parts most disposed to Cancer are those peculiar to the sexes, as the breasts and uterus in women and the testicles in men. Can-

* [The distinction between the various forms of medullary disease and cancer was not well understood in the time of Hunter, and consequently he has classed together several diseases which modern pathologists have very properly separated. It is unquestionably true that cancer may exhibit itself before the age of forty, and fungus hæmatodes after that period; still, as a general rule this does not happen, nor is there any individual fact more characteristic of the difference of these diseases than the different periods of life at which they respectively occur.]

cers are more frequent in women than in men, in the proportion of three to two; owing, perhaps, to the more frequent changes taking place in these parts in the former. It is that change which renders them unfit for conception and changes the whole system, which is particularly obnoxious. Thus, the three disposing causes are: 1st, a peculiar part; 2d, the age of the patient; and 3d, the peculiarities of the part at this age. The parts next in order and frequency, and which are common to both sexes, are the conglomerate glands about the lips, nose, throat, tongue, pancreas, stomach, especially the pylorus; intestines, especially the rectum. Besides these, we have it in the eyes and glans penis. The disease also appears in other parts of the body; but, as most other parts are similar in structure, it does not attack one more than another. It sometimes falls on the bones from contamination, but on no one in particular.

Whether Hereditary.—Some suppose cancers to be hereditary; but this I can only admit according to my principles of hereditary right; that is, supposing a person to possess a strong disposition or susceptibility for a particular disease, the children may also; but I have not yet ascertained the generality of this fact. In many persons it would appear that some of the predisposing causes are sufficient to become the immediate ones; as when the diseased action takes place at a certain stated time, without any immediate cause. Are they more frequent in one country than another? I have heard they are very rare in the West Indies; and they do not seem to be frequent in the Friendly Islands, where the women fight for prizes, and aim chiefly at the breast; so, most probably, climate has some power, both in disposing to the disease and in preventing it.

Symptoms.—On the first appearance of a cancer it is a hard tumour, and being specific it is circumscribed, having its specific distance, when it is called scirrhus, which is a cancer not yet ulcerated. Sometimes the first symptoms of a cancer in the breast is a bleeding from the nipple, which must come from the ducts of the lactiferous tubes; and this I have seen in men. In the testicle it sometimes begins by forming a hard knot, but is generally more universal. When in the lip, there is a thickening of some part of it, and this increases till ulceration takes place: it comes on similarly in the nose. There is one peculiarity in cancers, which is, that when the skin is affected there is a wrinkling or tucking in of it, which appearance always leads to suspicion of cancer. It often begins in the antrum, and distends the whole face; but I rather suspect this to be of the fungated kind. In the bones it begins by a soft swelling, which I also suspect to be fungated, from its forming such luxuriant fungoid granulations when ulcerated. In the testicle sometimes a softness and even an obscure fluctuation may be felt, although I suspect this not to be cancerous. The pain at first is so trifling as scarcely to be noticed; but when there is a disposition to suppuration and ulceration, a shooting lancinating pain is felt, and also a dead heavy one, which pain increases more in propor-

tion than the disease appears to do. It is more violent in some parts than in others, depending in some degree on the sensibility of the part; thus, it is more violent in the breast and testicle than in less sensible parts. Cancer, however, produces no symptoms peculiar to itself; they are only such as would arise from any injury to the part capable of producing the above effects, independently of any specific quality. Cancer of the lip, of the nose, or of any other part, will produce no peculiar symptoms; but in the testicle, symptoms peculiar to that part will be occasioned, as, for example, pain in the loins and sickness, with suppression of the secretion of semen; in the bladder, the symptoms will be like those of stone; in the rectum, purging and tenesmus; in the stomach, sickness and vomiting; within the skull, headache and coma. Cancer appears to give rise to no constitutional symptoms, except such as would arise in other diseases from the long-continued wearing pain and perpetual discharge.

The progress towards suppuration is of two kinds: one by external ulceration, the other by the scirrhous becoming encysted. The first happens when the tumour reaches the skin and affects that part with disease, when the skin first becomes shining and then ulcerates and forms a sore which is called a cancer. While this is taking place, inflammation is beginning from internal exposure, and the exposure increases the inflammation. The other mode depends on a change in the substance of the tumour itself akin to suppuration, but which is very different from any other kind of suppuration. The cavity contains a fluid, which fluid appears of various kinds, and in some cases begins very early. In some breasts, where such an encysted tumour has been removed, many small knots are found during the operation, by either cutting through or against them: they often suppurate without any inflammation, therefore there is seldom any inflammation until there has first been exposure. When the matter has been evacuated, common inflammation and suppuration take place, and the disease then proceeds rapidly.

Cancerous matter may be reckoned of two kinds: first, that in the tumour, which is various; in some serum, in some blood, and in others coagulable lymph, or else a yellow curdly matter. The second is of a bad quality, and proceeds from the internal cavity, which is similar in all respects to that formed externally by ulceration. The fluid from a cancerous ulcer is most commonly of a purplish red, which makes the skin of that colour; the absorption here seems to be of the intermediate substance between the skin and cyst. When near to the skin, it inflames and ulcerates as in other ulcerations.

Of the Treatment.—No cure has yet been found; for what I call a cure is an alteration of the disposition and the effect of that disposition, and not the destruction of the cancerous parts. But as we have no such medicine, we are often obliged to remove cancerous parts; which extirpation, however, will often cure as well as we could do by changing the disposition and action. Arsenic

seems to have some power of this kind, and its effects might be increased, by being used internally and externally; but its use is very dangerous, and I am afraid insufficient for the disease. This is a remedy which enters into the empirical nostrums which are in vogue for curing cancer; and among which Plunkett's holds the highest rank. But this is no new discovery, for Sennertus, who lived the Lord knows how long ago, mentions a Roderigues and Flusius, who obtained considerable fame and fortune by such a composition. I was desired to meet Mr. Plunkett, to decide on the propriety of using his medicine in a particular case: I have no objection to meet anybody: it was the young one; the old one is dead, and might have died himself of a cancer for aught I know. I asked him what he intended to do with his medicine. He said, "To cure the patient." "Let we know what you mean by that: do you mean to alter the diseased state of the parts? or do you mean by your medicine to remove the parts diseased?" "I mean to destroy them," he replied. "Well then, that is nothing more than I or any other surgeon can do with less pain to the patient." Poor Woollett the engraver died under one of these cancer-curers; he was under my care when this person took him in hand. He had been a life-guardsmen, I think, and had got a never-failing receipt. I continued to call on Woollett as a friend, and received great accounts of the good effects; upon hearing which, I said, if the man would give me leave to watch regularly the appearance of the cancer, and see myself the good effects, and should be satisfied of its curing only that cancer, (mind, not by destroying it,) I would exert all my power to make him the richest man in the kingdom. But he would have nothing to do with me, and tortured poor Woollett for some time; till at last I heard the sound testicle was gone, and at length he died.

Arsenic may be given internally with safety. If applied externally to a large surface, it will often affect the constitution, though to a small one it may be safe and efficacious; as, for example, a grain of arsenic to four ounces of water, applied in a poultice twice a day; this will often destroy the cancerous disposition and render the sore more healthy. Sometimes the quantity of arsenic must be increased, and when it gets better, less must be used. When the cancerous disposition is too strong to be removed by this means, we must destroy the parts; and for this there are two modes: 1st, by destroying the life of it; 2dly, by an operation. The destruction of all the cancerous parts is the intention in both: in destroying locally any specific disease which has the power of its own increase, the whole must be destroyed. That first method I divide into two: 1st, the power which life has of destroying itself, by producing an action it cannot support; 2dly, by chemical effects. The second method is by an operation; but the first method is not so extensive as the second, for with the knife we can go where the other cannot reach; so that the first can only be employed where the disease is exposed and circumscribed. When lying on a nerve or artery, the deadening method has the recommendation of safety.

The first mode produces too much action, as would appear from the effect of arsenic, which does not act chemically, but produces inflammation, and probably weakness also; so that the diseased parts will be destroyed by it, while the sound parts will remain alive; and this makes it preferable to caustic, which is not only too violent, but deadens the sound parts as well as the unsound. Plunkett's medicine is made as follows: crowsfoot, 3 drachms and 2 scruples; dogfennel dried, 1 drachm; crude sulphur, 2 drachms and a half; white arsenic, 5 drachms: beat in a mortar, and form into a powder; one or two drachms of which are to be mixed with the yolk of an egg, and being spread on a piece of bladder to be applied so as to cover the sore.* Arsenic alone would produce too violent an inflammation, and destroy the sound parts by mortification. The second, or chemical mode, is by caustics, by which life is destroyed by the combination of the caustic with the parts it comes in contact with, making but little distinction between those which are sound and those which are unsound; but these cannot be used very extensively, for obvious reasons.

The Second mode, or Extirpation.—In considering the propriety of this we must often be more careful than in the above modes; and as the knife may be extended further, so the diseases may be more complicated than in the other modes. We should first consider if the whole disease can be safely extirpated, and if so, the operation is proper. Some cannot be extirpated safely, as when in the extremities; but in such cases the whole limb may be safely removed, which should in doubtful cases always be done. But sometimes in the breast it is so fixed to the ribs as not to be entirely removeable. Now to know if a cancer is proper for operation, two things should be considered, viz. the cancer itself, and its consequences. Great attention should be paid to the tumour, whether it is moveable or not; for as the disease is further extended, so the parts are more united to the tumour. If it reaches a part which cannot be removed as the hips, or parts which cannot wholly be removed by amputation, then nothing can be done; but if the tumour is not only moveable, but the part naturally so, then there is no impropriety in removing it, with regard to the tumour itself; but before removing it, or a limb, we must consider if there are any consequences. We should examine for example, the glands in the groin or axilla to ascertain if they are thickened or swollen, and also the course of the absorbents; for if these are sound and moveable, then the disease may be safely removed. But if any are so deep or fixed as not to admit of removal, then we must consider whether the whole limb can be removed, above the consequent tumours; and if not, we ought to do nothing. All the above circumstances being considered, and no objections existing, the breast may be safely removed; and if any consequent cancers easy of extirpation are found, they

* [Any preparation containing so much arsenic must be exceedingly unsafe and dangerous.]

may be safely removed also. But it requires very great caution to know if any of these consequent tumours are within proper reach, for we are apt to be deceived in regard to the lymphatic glands, which often appear moveable, when, on extirpation, a chain of them is found to run far beyond out of our reach, which renders the operation unsuccessful. As this is not easily known, I would, in most cases, where the lymphatic glands are considerably enlarged, advise that the case should be let alone. We cannot be too nice in our examination, nor often too rough-handed in the operation. In cases where the original and consequent tumours are circumscribed, and sufficiently moveable, the operation has generally been successful, being nothing more than a common wound. But the parts may have acquired the diseased action, and thus render the operation unsuccessful, although that action was invisible. Whenever there are such appearances the parts should be removed as soon as possible: on the contrary, when the disease has not been entirely removed by the knife, from its not having been carried into the sound parts, the operation is unsuccessful; and these are the circumstances which gave the idea of the disease being constitutional: but let us observe what part of the sore does not heal, and what part breaks out again after the operation. This is either in the cicatrix, or in the lymphatic glands. Now, if the whole disease is not removed, the sore either does not heal, or if it does, the cicatrix breaks out again; so likewise, if the surrounding contaminated parts are not removed, although the whole original disease is, then, some months after, there will be a new ulceration there; and so with regard to the glands also, if any of these are so far diseased as to require extirpation, but too high up for the knife. I have sometimes seen, after the operation, the glands under the clavicle swell, and push out the clavicle on the lower part of the neck; it has also happened, that after removing the glands in the axilla the absorbents between them and the original disease have become contaminated, in which case they should be removed as soon as possible. The contamination extends in other instances on the inside of the sternum, in the course of the internal mammary artery. Sometimes these consequent cancers appear long after the operation, even years, when they should be immediately removed. After the visible disease is removed, we should minutely examine the sore, so as to feel and press every part, and if any thing is hard or irregular, remove it. After operation in the axilla, we should introduce the finger into it, in order to discover if any of the other glands are affected; and before the part is dressed the tumour itself should be inspected, to see if there are any corresponding appearances, so as to lead to the supposition of a part being left; but this can only be done in those from the breast, those only being circumscribed. Having once had the misfortune to leave a part, I let it go on for a few days, when the sore granulated healthily all over, except at that part, which had a blueish appearance, and discharged a dark coloured matter. I then dissected that bit only, and the patient

recovered. If a contaminated part is left, it comes into action in a few months after the operation; and if two or more are left, they all appear about the same time, and should be removed if they can as soon as possible, before they have contaminated other parts, when, in general, it will succeed, as far as I have seen. If these are not removed, other parts will be contaminated, and kill in the end; but if parts contaminated do not come into action at the same time, after the original is removed, we shall not succeed. It is surprising to see how a young man, if he catches an idea which has any novelty, will write away on it and tell you wonders. Thus, Mr. Fearen has lately recommended healing by the first intention in this disease, which is the last thing to be thought of, as we have here only in view the total removal of the disease, and not the healing of the wounds. But no man should write a book without taking every circumstance of the disease into consideration; he should not write from a single idea, which many circumstances may render futile. I have used this plan in small circumscribed cases in the breast, where there was very much skin, although I have been very liberal of my removal at the same time.

Of the effects of Cancer in the Breast when incurable.—When the glands become indurated the fluids are not absorbed, in consequence of which there is a stagnation and extravasation of serum, causing œdema of the parts around. The arm, and the integuments of the chest below, swell, and the fingers are sometimes rendered immovable, and very painful. The inflammation about the diseased parts spreads, and causes a tightness around, which occasions dyspnœa, and in this stage sympathetic cancerous tumours often arise at a distance, and hectic fever comes on. We must now give large doses of opium, which yet do not often relieve the pain. I have seen the œdema of the arm before there was any tumefaction of the lymphatic glands; but when œdema occurs, which is not the consequence of absorption, there may nevertheless be afterwards hardness of the glands from this cause: however, the œdema above mentioned puzzled me, having never before seen it without the glands being enlarged, and I have never seen another case.

Of the Cancerous Testicle.—The same observations are here applicable as in the breast, with respect to the propriety or impropriety of an operation. If the cord is thickened the operation is doubtful, the consequence going often further than at first appears. If it has not extended so high as the ring, I would advise extirpation, it being the only resource left. When the testicle has affected the scrotum there may be absorption to the glands of the groin, as in lues; of this I have seen one case, where, half a year after the operation for the removal of the testicle and scrotum, the glands in the groin ulcerated, and killed the patient. In this case the testicle had become adherent to the scrotum. I cannot say how far it would have been proper to have removed these glands at first, but from the adhesion the scrotum was necessarily removed. I was at

first puzzled to account for the appearance of cancer in the groin, as we know the testicle receives its vessels, &c., from the loins, and therefore the glands in the loins become affected by the disease extending along the course of the cord; but when I recollected that the scrotum was affected, I knew it to be owing to the lymphatics of the scrotum, which pass through the groin. In cancerous diseases the surrounding parts become contaminated, and these again contaminate others; but in scrofulous suppuration the surrounding parts, although affected, are not scrofulous, because this is not a poisonous disease. Before suppuration breaks out we can form little idea of the state of the part as to its malignancy: but after it breaks out we can, for if healthy it will recover itself, and granulate healthily; but if the contrary, it will not; hence, in the suppuration of the testicle, we cannot say whether it is scrofulous or cancerous till it is ulcerated, when the mode of healing informs us of the disease.

Of Cancer of the Lip.—If small, the operation for the hare lip should be preferred, and it is right in this case to have the cure in view as soon as the operation is done, although we should be sure to remove the whole disease. These principles attended to will be sufficient to guide us in the management of cancers in other parts of the body.

Of Fungated Sores.—These are commonly called cancers, and are similar to them in being incurable, although they differ in other respects. The cancer eats, as it were, away parts, though there is still an increase of growth or tumefaction; but in fungated sores there is a spongy fungus which cannot be kept down. It is, in fact, a specific well-marked disease, which appears common to every part, which I believe the cancer is not. I have seen it in the antrum, the tibia, the eye, the testicle, and the rectum. Its beginning, I believe, is in the form of a tumour, both of the encysted and solid kind; for I have seen an encysted tumour opened which threw out this fungus, which is very soft, spongy, and pulpy, of a dirty black colour, very easily torn, and very apt to bleed: the matter does not seem to be poisonous, for the glands and absorbents never appear to be diseased by it. Here [*exhibiting it*] is a preparation to show the disease on the sole of the foot, and here another, of the tunica vaginalis, in which the fungus was very extensive, as was also this fungus on the penis. A woman had a large one on the upper part of the foot, for which I amputated the leg, and in this case the glands in the groin were not affected, and she recovered, which shows there was no poison to contaminate by absorption. A man had a swelled testicle, which was not very painful, and the cord was not affected, which led me to think that it was scrofulous; the scrotum became affected by local sympathy, and adhered to the testicle. I removed the testicle, but not entirely the adhering skin, and after some time a fungus arose from the skin, and his health became impaired by the repeated hemorrhage. I tried arsenic made into troches with flour, which were stuck into the fungus, but still these did not destroy it sufficiently, and the man afterwards died.

If this had been cancerous the progress would have been different, for the skin would have become cancerous from contamination, and the cord would probably have been affected in the same way. On dissection of this fungus from the cicatrix of the old skin the glands above were found sound. This species of fungus is pretty regular in structure; it is striated, and radiated, and its external surface is larger than that of the surface of contact. Nothing is left for it but to remove it, no natural cure being known; but we should be careful to remove the whole of the diseased parts that have the disposition, as they will otherwise soon take on the action. It kills without appearing to have done much mischief, whereas cancer does much local mischief, and so do the consequent ones, before death. The first case of fungated ulcer from accident which I ever saw was one from a blow on the arm, which was afterwards obliged to be amputated.

Cancerous Diseases of the Penis are somewhat similar to the former, consisting of a fungus, which begins on the glans, and increases till the whole becomes an excrescence, which resembles the fungated sore when cut or torn, except that it is much slower in its progress: sometimes it attains a large size, and appears like a cauliflower; and sometimes it is in the form of a tumour, covered with skin, and ulcerated at some parts only. These tumours may, I think, be classed with the true tumours, which consist of a new-formed substance; but I do not think they ever arise from the venereal disease, as has been supposed. Extirpation, in my judgment, is the only surgical resource; and if so, it should be done as early and as effectually as possible.

The Hæmatocele Specifica Testis takes its name from the nature of the contents, which are blood, serum, or often a firm coagulated blood, the extravasation arising from a diseased action, or a peculiar mode of secretion, and not immediately from accident, as is the case with one species, which leads me to call this hæmatocele specifica testis. It is often taken for a cancerous testicle, and removed for such, and the fluid blood is then mistaken for cancerous extravasation, though it is common extravasated blood in the tunica vaginalis; although I will not deny that there may be new cysts occasionally found that may contain blood, as other new cysts do matter. Those which I have seen have felt like an obscure hydrocele, or something between hydrocele and scirrhus testicle. (See note, p. 232.) As it is so uncertain what is the true case, I have always advised tapping in the first place. In some there is much serum, and this in the centre of the coagulum, which adheres to the sides of the sac, the whole feeling like a thickened sac; and often the sac is really much thickened. In some the testicle has been so pressed as to burst, and to fill the cavity of the tunica vaginalis; but whether this is a specific disease or not, or a cancer similar to that in the breast, I do not know. I rather think it is specific, but if not specific, the treatment of hydrocele would be proper; but it must be distinguished from sarcocele, as in that a different treatment is necessary. But we find

it will not admit of the same cure as hydrocele. The coagulum adhering to the sac keeps off the stimulus of imperfection, and prevents a cure, so that in many cases it would be perhaps best to dissect out the whole tunica vaginalis. Perhaps in some the blood may become part of the solids, by becoming vascular, as was shown in a preparation. A gentleman in China had, he thought, a swelled testicle, for which he used mercurial ointment. On coming to England, I could not determine the case, but rather thought it a hydrocele. I tapped him; but no fluid was discharged, although the lancet was pushed in an inch deep. Mr. Pott was called in, who thought it a scirrhus testicle, and the operation was performed. On examining it, a bloody serum was found in it, and the coats of the sac (which was the tunica vaginalis,) were extremely thick, and the testicle was much squeezed by it. I should think it was a mixed case, and might have been cured as hydrocele; but am not certain.

In a case of true hæmatocele there was first an uneasy sensation, and the testicle was painful to the touch afterwards; the swelling increased, and was mistaken by a surgeon for hydrocele; then the hardness increased, and the pain become acute; several punctures were now made, which brought on much inflammation, which required that an opening should be made, in order to examine the parts, which were found to consist of grumous blood and a thickened coat. It was advised that all should be removed, together with some of the skin: but I think not enough, for although the parts healed readily, yet some months afterwards a swelling in the abdomen reappeared, and destroyed him. On dissection, there was found a set of tumours extending to the diaphragm, on the epiploon, together with some others in the liver, respecting which it was a question whether they were scrofulous or cancerous; they went along the loins, in the course of the absorbents, showing them to be cancerous; but the tumours in the epiploon, which is a part not in the course of the absorbents, staggered me in that opinion, and other circumstances puzzled me still further. At present I know not where to class this disease, but I find it has not the powers of recovery when put in the way of it by exposure.

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PLATES

TO

HUNTER'S LECTURES

ON

THE PRINCIPES OF SURGERY.

PLATE I.

Fig. 1.



Fig. 2.



Fig. 3.

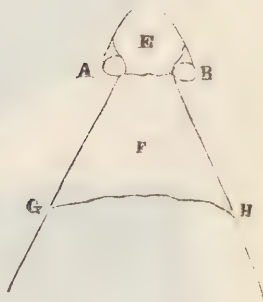


PLATE II.

Fig. 1.



Fig. 2.

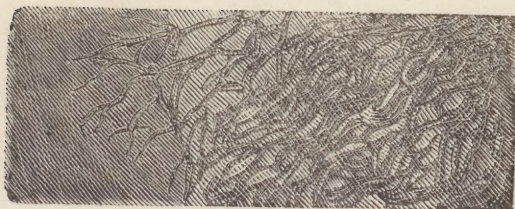


PLATE III.

Fig. 1.

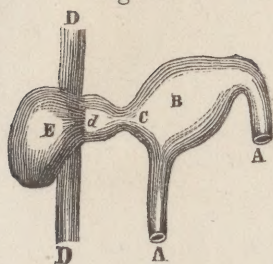


Fig. 3.



Fig. 4.

